CUNNINGHAM'S MANUAL

OF

PRACTICAL ANATOMY

REVISED AND EDITED BY

ARTHUR ROBINSON

PROFESSOR OF ANATOMY IN THE UNIVERSITY OF EDINBURGH

SEVENTH EDITION

VOLUME FIRST

SUPERIOR EXTREMITY; INFERIOR EXTREMITY

WITH 203 ILLUSTRATIONS, MANY OF WHICH ARE COLOURED

NEW YORK

WILLIAM WOOD AND COMPANY

EDINBURGH, GLASGOW, AND LONDON

HENRY FROWDE AND HODDER & STOUGHTON

1921

Printed in Great Britain by R. & R. CLARK, LIMITED, *Edinburgh.*

1*st Edition*, 1896.
2*nd Edition*, 1903.
3*rd Edition*, 1906.
4*th Edition*, 1907.
5*th Edition*, 1912.
6*th Edition*, 1914.
6*th Edition*, 2*nd Impression*, 1917.
6*th Edition*, 3*rd Impression*, 1918.
7*th Edition*, 1920.
7*th Edition*, 2*nd Impression*, 1921

PREFACE TO THE SEVENTH EDITION

In this edition the general text has been revised, many new figures, representing dissections, sections and radiographs, have been introduced. The instructions for dissection have been printed in a distinctive indented type; in many cases they have been rewritten and in some cases amplified.

The latter changes, together with the additional figures, have caused so much increase of size that it has been deemed advisable to publish the book in three volumes. Vol. I.: Superior Extremity and Inferior Extremity; Vol. II.: Thorax and Abdomen; Vol. III.: Head and Neck.

As was the case in previous editions, I am indebted to Dr. E. B. Jamieson for many suggestions, for his invaluable help in the revision of the text and for the preparation of the Index.

My thanks are due to Dr. Robert Knox, to Major A. W. Pirie and to Major T. Rankin for the use of radiographs, which they very kindly prepared for me, and to Mr. J. T. Murray for the new drawings of sections and dissections.

ARTHUR ROBINSON.

Oct. 11, 1919.

CONTENTS

THE SUPERIOR EXTREMITY.

THE INFERIOR EXTREMITY.

A GLOSSARY

OF THE

INTERNATIONAL (B.N.A.) ANATOMICAL TERMINOLOGY

GENERAL TERMS.

Terms indicating Situation and Direction.

Longitudinalis	Longitudinal	Referring to the long axis of the body.
Verticalis	Vertical	Referring to the position of the long axis of the body in the erect posture.
Anterior Posterior	Anterior Posterior	Referring to the front and back of the body or of the limbs.
Ventral Dorsal	Ventral Dorsal	Referring to the anterior and posterior aspects, respectively, of the body, and to the flexor and extensor aspects of the limbs, respectively.
Cranial Caudal	Cranial Caudal	Referring to position nearer the head or the tail end of the long axis. Used only in reference to parts of the head, neck, or trunk.
Superior Inferior	Superior Inferior	Used in reference to the head, neck, and trunk. Equivalent to cranial and caudal respectively.
Proximalis Distalis	Proximal Distal	Used only in reference to the limbs. Proximal nearer the attached end. Distal nearer the free end.
Sagittalis	Sagittal	Used in reference to planes parallel with the sagittal suture of the skull, *i.e.* vertical antero-posterior planes.
Frontalis	Frontal	Used in reference to planes parallel with the coronal suture of the skull, *i.e.* transverse vertical planes.

Horizontalis	Horizontal	Used in reference to planes at right angles to vertical planes.
Medianus	Median	Referring to the median vertical antero-posterior plane of the body.
Medialis Lateralis	Medial Lateral	Referring to structures relatively nearer to or further away from the median plane.
Intermedius	Intermediate	Referring to structures situated between more medial and more lateral structures.
Superficialis Profundus	Superficial Deep	Referring to structures nearer to and further away from the surface.
Externus Internus	External Internal	Referring, with few exceptions, to the walls of cavities and hollow organs. *Not* to be used as synonymous with medial and lateral.
Ulnaris Radialis	Ulnar Radial	Used in reference to the medial and lateral borders of the forearm, respectively.
Tibial Fibular	Tibial Fibular	Used in reference to the medial and lateral borders of the leg, respectively.

THE BONES.

B.N.A. Terminology.	Old Terminology.
Vertebræ	**Vertebræ**
Fovea costalis superior	Incomplete facet for head of rib, upper
Fovea costalis inferior	Incomplete facet for head of rib, lower
Fovea costalis transversalis	Facet for tubercle of the rib
Radix arcus vertebræ	Pedicle
Atlas	**Atlas**
Fovea dentis	Facet for odontoid process
Epistropheus	**Axis**
Dens	Odontoid process
Sternum	**Sternum**
Corpus sterni	Gladiolus
Processus xiphoideus	Ensiform process
Incisura jugularis	Supra-sternal notch
Planum sternale	Anterior surface
Ossa Cranii.	**Bones of Skull.**
Os frontale	**Frontal**
Spina frontalis	Nasal spine
Processus zygomaticus	External angular process
Facies cerebralis	Internal surface
Facies frontalis	Frontal surface
Pars orbitalis	Orbital plate

B.N.A. Terminology.	Old Terminology.
Os parietale	**Parietal**
Lineæ temporales	Temporal ridges
Sulcus transversus	Groove for lateral sinus
Sulcus sagittalis	Groove for sup. long. sinus
Os occipitale	**Occipital**
Canalis hypoglossi	Anterior condyloid foramen
Foramen occipitale magnum	Foramen magnum
Canalis condyloideus	Posterior condyloid foramen
Sulcus transversus	Groove for lateral sinus
Sulcus sagittalis	Groove for sup. long. sinus
Clivus	Median part of upper surface of basi-occipital
Linea nuchæ suprema	Highest curved line
Linea nuchæ superior	Superior curved line
Linea nuchæ inferior	Inferior curved line
Os sphenoidale	**Sphenoid**
Crista infratemporalis	Pterygoid ridge
Sulcus chiasmatis	Optic groove
Crista sphenoidalis	Ethmoidal crest
Spina angularis	Spinous process
Lamina medialis processus pterygoidei	Internal pterygoid plate
Lamina lateralis processus pterygoidei	External pterygoid plate
Canalis pterygoideus [Vidii]	Vidian canal
Fossa hypophyseos	Pituitary fossa
Sulcus caroticus	Cavernous groove
Conchæ sphenoidales	Sphenoidal turbinal bones
Hamulus pterygoideus	Hamular process
Canalis pharyngeus	Pterygo-palatine canal
Tuberculum sellæ	Olivary eminence
Fissura orbitalis superior	Sphenoidal fissure
Os temporale	**Temporal Bone**
Canalis facialis [Fallopii]	Aqueduct of Fallopius
Hiatus canalis facialis	Hiatus Fallopii
Vagina processus styloidei	Vaginal process of tympanic bone
Incisura mastoidea	Digastric fossa
Impressio trigemini	Impression for Gasserian ganglion
Eminentia arcuata	Eminence for sup. semicircular canal
Sulcus sigmoideus	Fossa sigmoidea
Fissura petrotympanica	Glaserian fissure
Fossa mandibularis	Glenoid cavity
Semicanalis tubæ auditivæ	Eustachian tube
Os ethmoidale	**Ethmoid**
Labyrinthus ethmoidalis	Lateral mass
Lamina papyracea	Os planum
Processus uncinatus	Unciform process

B.N.A. Terminology.	Old Terminology.
Os lacrimale	**Lachrymal Bone**
Hamulus lacrimalis	Hamular process
Crista lacrimalis posterior	Lachrymal crest
Os nasale	**Nasal Bone**
Sulcus ethmoidalis	Groove for nasal nerve
Maxilla	**Superior Maxillary Bone**
Facies anterior	Facial or external surface
Facies infra-temporalis	Zygomatic surface
Sinus maxillaris	Antrum of Highmore
Processus frontalis	Nasal process
Processus zygomaticus	Malar process
Canales alveolares	Posterior dental canals
Canalis naso-lacrimalis	Lacrimal groove
Os incisivum	Premaxilla
Foramen incisivum	Anterior palatine foramen
Os palatinum	**Palate Bone**
Pars perpendicularis	Vertical plate
Crista conchalis	Inferior turbinate crest
Crista ethmoidalis	Superior turbinate crest
Pars horizontalis	Horizontal plate
Os zygomaticum	**Malar Bone**
Processus temporalis	Zygomatic process
Processus fronto-sphenoidalis	Frontal process
Foramen zygomatico-orbitale	Tempora-malar canal
Foramen zygomatico-faciale	Malar foramen
Mandibula	**Inferior Maxillary Bone**
Spina mentalis	Genial tubercle or spine
Linea obliqua	External oblique line
Linea mylohyoidea	Internal oblique line
Incisura mandibulæ	Sigmoid notch
Foramen mandibulare	Inferior dental foramen
Canalis mandibulæ	Inferior dental canal
Protuberantia mentalis	Mental process

The Skull as a Whole.

Ossa suturarum	Wormian bones
Foveolæ granulares (Pacchioni)	Pacchionian depressions
Fossa pterygo-palatina	Spheno-maxillary fossa
Canalis pterygo-palatinus	Posterior palatine canal
Foramen lacerum	Foramen lacerum medium
Choanæ	Posterior nares
Fissura orbitalis superior	Sphenoidal fissure
Fissura orbitalis inferior	Spheno-maxillary fissure

Upper Extremity.

B.N.A. Terminology.	Old Terminology.
Clavicula	**Clavicle**
Tuberositas coracoidea	Impression for conoid ligament
Tuberositas costalis	Impression for rhomboid ligament
Scapula	**Scapula**
Incisura scapularis	Supra-scapular notch
Angulus lateralis	Anterior or lateral angle
Angulus medialis	Superior angle
Humerus	**Humerus**
Sulcus intertubercularis	Bicipital groove
Crista tuberculi majoris	External lip
Crista tuberculi minoris	Internal lip
Facies anterior medialis	Internal surface
Facies anterior lateralis	External surface
Margo medialis	Internal border
Margo lateralis	External border
Sulcus nervi radialis	Musculo-spiral groove
Capitulum	Capitellum
Epicondylus medialis	Internal condyle
Epicondylus lateralis	External condyle
Ulna	**Ulna**
Incisura semilunaris	Greater sigmoid cavity
Incisura radialis	Lesser sigmoid cavity
Crista interossea	External or interosseous border
Facies dorsalis	Posterior surface
Facies volaris	Anterior surface
Facies medialis	Internal surface
Margo dorsalis	Posterior border
Margo volaris	Anterior border
Radius	**Radius**
Tuberositas radii	Bicipital tuberosity
Incisura ulnaris	Sigmoid cavity
Crista interossea	Internal or interosseous border
Facies dorsalis	Posterior surface
Facies volaris	Anterior surface
Facies lateralis	External surface
Margo dorsalis	Posterior border
Margo volaris	Anterior border
Carpus	**Carpus**
Os naviculare	**Scaphoid**
Os lunatum	**Semilunar**
Os triquetrum	**Cuneiform**
Os multangulum majus	**Trapezium**
Os multangulum minus	**Trapezoid**
Os capitatum	**Os magnum**
Os hamatum	**Unciform**

Lower Extremity.

B.N.A. Terminology.	Old Terminology.
Os coxæ	**Innominate Bone**
Linea glutæa anterior	Middle curved line
Linea glutæa posterior	Superior curved line
Linea terminalis	Margin of inlet of true pelvis
Spina ischiadica	Spine of the ischium
Incisura ischiadica major	Great sacro-sciatic notch
Incisura ischiadica minor	Lesser sacro-sciatic notch
Tuberculum pubicum	Spine of pubis
Ramus inferior oss. pubis	Descending ramus of pubis
Ramus superior oss. pubis	Ascending ramus of pubis
Ramus superior ossis ischii	Body of ischium
Ramus inferior oss. ischii	Ramus of ischium
Pecten ossis pubis	Pubic part of ilio-pectineal line
Facies symphyseos	Symphysis pubis
Pelvis	**Pelvis**
Pelvis major	False pelvis
Pelvis minor	True pelvis
Apertura pelvis minoris superior	Pelvic inlet
Apertura pelvis minoris inferior	Pelvic outlet
Linea terminalis	Margin of inlet of true pelvis
Femur	**Femur**
Fossa trochanterica	Digital fossa
Linea intertrochanterica	Spiral line
Crista intertrochanterica	Post. intertrochanteric line
Condylus medialis	Inner condyle
Condylus lateralis	Outer condyle
Epicondylus medialis	Inner tuberosity
Epicondylus lateralis	Outer tuberosity
Tibia	**Tibia**
Condylus medialis	Internal tuberosity
Condylus lateralis	External tuberosity
Eminentia intercondyloidea	Spine
Tuberositas tibiæ	Tubercle
Malleolus medialis	Internal malleolus
Fibula	**Fibula**
Malleolus lateralis	External malleolus
Apex capituli fibulæ	Styloid process

Bones of the Foot.

Talus	**Astragalus**
Calcaneus	**Os calcis**
Tuber calcanei	Tuberosity of
Processus medialis tuberis calcanei	Inner
Processus lateralis tuberis calcanei	Outer
Os cuneiforme primum	**Inner cuneiform**
Os cuneiforme secundum	**Middle cuneiform**
Os cuneiforme tertium	**Outer cuneiform**

THE LIGAMENTS.

Ligaments of the Spine.

B.N.A. Terminology.	Old Terminology.
Lig. longitudinale anterius	Anterior common ligament
Lig. longitudinale posterius	Posterior common ligament
Lig. flava	Ligamenta subflava
Membrana tectoria	Posterior occipito-axial ligament
Articulatio atlanto-epistrophica	Joint between the atlas and the axis
Lig. alaria	Odontoid or check ligaments
Lig. apicis dentis	Suspensory ligament

The Ribs.

Lig. capituli costæ radiatum	Anterior costo-vertebral or stellate ligament
Lig. sterno-costale interarticulare	Interarticular chondro-sternal ligament
Lig. sterno-costalia radiata	Anterior and posterior chondro-sternal ligament
Lig. costoxiphoidea	Chondro-xiphoid ligaments

The Jaw.

Lig. temporo-mandibulare	External lateral ligament of the jaw
Lig. spheno-mandibulare	Internal lateral ligament of the jaw
Lig. stylo-mandibulare	Stylo-maxillary ligament

Upper Extremity.

Lig. costo-claviculare	Rhomboid ligament
Labrum glenoidale	Glenoid ligament
Articulatio radio-ulnaris proximalis	Superior radio-ulnar joint
Lig. collaterale ulnare	Internal lateral ligament of elbow joint
Lig. collaterale radiale	External lateral ligament
Lig. annulare radii	Orbicular ligament
Chorda obliqua	Oblique ligament of ulna
Articulatio radio-ulnaris distalis	Inferior radio-ulnar joint
Discus articularis	Triangular fibro-cartilage
Recessus sacciformis	Membrana sacciformis
Lig. radio-carpeum volare	Anterior ligament of the radio-carpal joint
Lig. radio-carpeum dorsale	Posterior ligament of the radio-carpal joint
Lig. collaterale carpi ulnare	Internal lateral ligament of the wrist joint

B.N.A. Terminology.	Old Terminology.
Lig. collaterale carpi radiale	External lateral ligament of the wrist joint
Articulationes intercarpæ	Carpal joints
Lig. accessoria volaria	Palmar ligaments of the metacarpo-phalangeal joints
Lig. capitulorum (oss. metacarpalium) transversa	Transverse metacarpal ligament
Lig. collateralia	Lateral phalangeal ligaments

The Lower Extremity.

Lig. arcuatum	Subpubic ligament
Lig. sacro-tuberosum	Great sacro-sciatic ligament
Processus falciformis	Falciform process
Lig. sacro-spinosum	Small sacro-sciatic ligament
Labrum glenoidale	Cotyloid ligament
Zona orbicularis	Zonular band
Ligamentum iliofemorale	Y-shaped ligament
Lig. ischio-capsulare	Ischio-capsular band
Lig. pubo-capsulare	Pubo-femoral ligament
Lig. popliteum obliquum	Ligament of Winslow
Lig. collaterale fibulare	Long external lateral ligament
Lig. collaterale tibiale	Internal lateral ligament
Lig. popliteum arcuatum	Arcuate popliteal ligament
Meniscus lateralis	External semilunar cartilage
Meniscus medialis	Internal semilunar cartilage
Plica synovialis patellaris	Lig. mucosum
Plicæ alares	Ligamenta alaria
Articulatio tibio-fibularis	Superior tibio-fibular articulation
Lig. capituli fibulæ	Anterior and posterior superior tibio-fibular ligaments
Syndesmosis tibio-fibularis	Inferior tibio-fibular articulation
Lig. deltoideum	Internal lateral ligament of ankle
Lig. talo-fibulare anterius	Anterior fasciculus of external lateral ligament
Lig. talo-fibulare posterius	Posterior fasciculus of external lateral ligament
Lig. calcaneo-fibulare	Middle fasciculus of external lateral ligament
Lig. talo-calcaneum laterale	External calcaneo-astragaloid ligament
Lig. talo-calcaneum mediale	Internal calcaneo-astragaloid ligament
Lig. calcaneo-naviculare plantare	Inferior calcaneo-navicular ligament
Lig. talo-naviculare	Astragalo-scaphoid ligament
Pars calcaneo-navicularis } lig. bifurcatum	Superior calcaneo-scaphoid ligament
Pars calcaneo-cuboidea } lig. bifurcatum	Internal calcaneo-cuboid ligament

THE MUSCLES.

Muscles of the Back.

Superficial.

B.N.A. Terminology.	Old Terminology.
Levator scapulæ	Levator anguli scapulæ

Muscles of the Chest.

Serratus anterior	Serratus magnus

Muscles of Upper Extremity.

Biceps brachii	Biceps
Lacertus fibrosus	Bicipital fascia
Brachialis	Brachialis anticus
Triceps brachii	Triceps
Caput mediale	Inner head
Caput laterale	Outer head
Pronator teres	Pronator radii teres
Caput ulnare	Coronoid head
Brachio-radialis	Supinator longus
Supinator	Supinator brevis
Extensor carpi radialis longus	Extensor carpi radialis longior
Extensor carpi radialis brevis	Extensor carpi radialis brevior
Extensor indicis proprius	Extensor indicis
Extensor digiti quinti proprius	Extensor minimi digiti
Abductor pollicis longus	Extensor ossis metacarpi pollicis
Abductor pollicis brevis	Abductor pollicis
Extensor pollicis brevis	Extensor primi internodii pollicis
Extensor pollicis longus	Extensor secundi internodii pollicis
Lig. carpi transversum	Anterior annular ligament
Lig. carpi dorsale	Posterior annular ligament

Muscles of Lower Extremity.

Tensor fasciæ latæ	Tensor fasciæ femoris
Canalis adductorius (Hunteri)	Hunter's canal
Trigonum femorale (fossa Scarpæ major)	Scarpa's triangle
Canalis femoralis	Crural canal
Annulus femoralis	Crural ring
M. quadriceps femoris—	Quadriceps—
Rectus femoris	Rectus femoris
Vastus lateralis	Vastus externus
Vastus intermedius	Crureus
Vastus medialis	Vastus internus
M. articularis genu	Subcrureus
Tibialis anterior	Tibialis anticus

B.N.A. TERMINOLOGY.	OLD TERMINOLOGY.
Tendo calcaneus	Tendo Achillis
Tibialis posterior	Tibialis posticus
Quadratus plantæ	Accessorius
Lig. transversum cruris	Upper anterior annular ligament
Lig. cruciatum cruris	Lower anterior annular ligament
Lig. laciniatum	Internal annular ligament
Retinaculum musculorum peronæorum superius Retinaculum musculorum peronæorum inferius	External annular ligament

Axial Muscles.

Muscles of the Back.

Serratus posterior superior	Serratus posticus superior
Serratus posterior inferior	Serratus posticus inferior
Splenius cervicis	Splenius colli
Sacro-spinalis	Erector spinæ
Ilio-costalis—	**Ilio-costalis**—
Lumborum	Sacro-lumbalis
Dorsi	Accessorius
Cervicis	Cervicalis ascendens
Longissimus—	**Longissimus**—
Dorsi	Dorsi
Cervicis	Transversalis cervicis
Capitis	Trachelo-mastoid
Spinalis—	**Spinalis**—
Dorsi	Dorsi
Cervicis	Colli
Capitis	Capitis
Semispinalis—	**Semispinalis**—
Dorsi	Dorsi
Cervicis	Colli
Capitis	Complexus
Multifidus	Multifidus spinæ

Muscles of Head and Neck.

Epicranius	Occipito-frontalis
Galea aponeurotica	Epicranial aponeurosis
Procerus	Pyramidalis nasi
Pars transversa (nasalis)	Compressor naris
Pars alaris (nasalis)	Dilatores naris
Auricularis anterior	Attrahens aurem
Auricularis posterior	Retrahens aurem
Auricularis superior	Attollens aurem
Orbicularis oculi	Orbicularis palpebrarum
Pars lacrimalis	Tensor tarsi

B.N.A. Terminology.	Old Terminology.
Triangularis	Depressor anguli oris
Quadratus labii superioris—	
Caput zygomaticum	Zygomaticus minor
Caput infraorbitale	Levator labii superioris
Caput angulare	Levator labii superioris alæque nasi
Zygomaticus	Zygomaticus major
Caninus	Levator anguli oris
Quadratus labii inferioris	Depressor labii inferioris
Mentalis	Levator menti
Platysma	Platysma myoides
Sterno-thyreoid	Sterno-thyroid
Thyreo-hyoid	Thyro-hyoid

Muscles and Fascia of the Orbit.

Fascia bulbi	Capsule of Tenon
Septum orbitale	Palpebral ligaments
Rectus lateralis	Rectus externus
Rectus medialis	Rectus internus

Muscles of the Tongue.

Genio-glossus	Genio-hyo-glossus
Longitudinalis superior	Superior lingualis
Longitudinalis inferior	Inferior lingualis
Transversus linguæ	Transverse fibres
Verticalis linguæ	Vertical fibres

Muscles of the Pharynx.

Pharyngo-palatinus	Palato-pharyngeus
M. uvulæ	Azygos uvulæ
Levator veli palatini	Levator palati
Tensor veli palatini	Tensor palati
Glosso-palatinus	Palato-glossus

Deep Lateral Muscles of Neck.

Scalenus anterior	Scalenus anticus
Scalenus posterior	Scalenus posticus
Longus capitis	Rectus capitis anticus major
Rectus capitis anterior	Rectus capitis anticus minor

Muscles of Thorax.

Transversus thoracis	Triangularis sterni
Diaphragma	Diaphragm
Crus mediale Crus intermedium Crus laterale	Crura and origins from arcuate ligaments
Arcus lumbo-costalis medialis (Halleri)	Ligamentum arcuatum internum
Arcus lumbo-costalis lateralis (Halleri)	Ligamentum arcuatum externum

Muscles of the Abdomen.

B.N.A. Terminology.	Old Terminology.
Ligamentum inguinale (Pouparti)	Poupart's ligament
Ligamentum lacunare (Gimbernati)	Gimbernat's ligament
Fibræ intercrurales	Intercolumnar fibres
Ligamentum inguinale reflexum (Collesi)	Triangular fascia
Annulus inguinalis subcutaneus	External abdominal ring
Crus superius	Internal pillar
Crus inferius	External pillar
Falx aponeurotica inguinalis	Conjoined tendon
M. transversus abdominis	Transversalis muscle
Linea semicircularis (Douglasi)	Fold of Douglas
Annulus inguinalis abdominalis	Internal abdominal ring

Perineum and Pelvis.

Transversus perinei superficialis	Transversus perinei
M. sphincter urethræ membranaceæ	Compressor urethræ
Diaphragma urogenitale	Deep transverse muscle and sphincter urethræ
Fascia diaphragmatis urogenitalis superior	Deep layer of triangular ligament
Fascia diaphragmatis urogenitalis inferior	Superficial layer of the triangular ligament
Arcus tendineus fasciæ pelvis	White line of pelvis
Ligamenta puboprostatica	Anterior and lateral true ligaments of bladder
Fascia diaphragmatis pelvis superior	Visceral layer of pelvic fascia
Fascia diaphragmatis pelvis inferior	Anal fascia

THE NERVOUS SYSTEM.

Medulla Spinalis.	Spinal Cord.
Fasciculus anterior proprius (Flechsig)	Anterior ground or basis bundle
Fasciculus lateralis proprius	Lateral ground bundle
Nucleus dorsalis	Clarke's column
Pars thoracalis	Dorsal part of spinal cord
Sulcus intermedius posterior	Paramedian furrow
Columnæ anteriores, etc.	Anterior grey column
Fasciculus cerebro-spinalis anterior	Direct pyramidal tract
Fasciculus cerebro-spinalis lateralis (pyramidalis)	Crossed pyramidal tract
Fasciculus cerebello-spinalis	Direct cerebellar tract
Fasciculus antero-lateralis superficialis	Gowers' tract

The Brain or **Encephalon** is divided into parts as follows :—

- **RHOMBENCEPHALON** = Myelencephalon (medulla) (after-brain) / Metencephalon (pons and cerebellum) (hind-brain) — Posterior primary vesicle.
- **CEREBRUM** = **MESENCEPHALON** (mid-brain, peduncles, corpora quadrigemina, etc.)—Middle primary vesicle.
  - **PROSENCEPHALON** (fore-brain)
    - **Diencephalon** = Thalamencephalon (inter-brain)
      - Thalamus (optic thalamus).
      - Metathalamus (geniculate bodies).
      - Epithalamus (pineal body).
    - Mammillary portion of hypothalamus (subthalamic region).
    - Posterior part of 3rd ventricle.
    - **Telencephalon**
      - Optic portion of hypothalamus (hypophysis).
      - Optic nerves.
      - Anterior part of 3rd ventricle.
    - Pallium (cortex cerebri).
    - Lateral ventricles.

Brain.

B.N.A. Terminology.	Old Terminology.
Rhombencephalon	
Eminentia medialis	Eminentia teres
Ala cinerea	Trigonum vagi
Ala acustica	Trigonum acusticum
Nucleus nervi abducentis	Nucleus of 6th nerve
Nuclei n. acustici	Auditory nucleus
Fasciculus longitudinalis medialis	Posterior longitudinal bundle
Corpus trapezoideum	Corpus trapezoides
Incisura cerebelli anterior	Semilunar notch (of cerebellum)
Incisura cerebelli posterior	Marsupial notch
Sulcus horizontalis cerebelli	Great horizontal fissure
Lobulus centralis	Lobus centralis
Folium vermis	Folium cacuminis
Tuber vermis	Tuber valvulæ
Lobulus quadrangularis	Quadrate lobule
Brachium conjunctivum cerebelli	Superior cerebellar peduncle
Lobulus semilunaris superior	Postero-superior lobule
Lobulus semilunaris inferior	Postero-inferior lobule
Cerebrum	
Pedunculus cerebri	Crus cerebri
Colliculus superior	Anterior corpus quadrigeminum
Colliculus inferior	Posterior corpus quadrigeminum
Aqueductus cerebri	Iter e tertio ad quartum ventriculum, or aqued. of Sylvius
Foramen interventriculare	Foramen of Monro
Hypothalamus	Subthalmic region
Sulcus hypothalamicus	Sulcus of Monro
Massa intermedia	Middle commissure
Fasciculus thalamo-mammillaris	Bundle of Vicq d'Azyr
Pars opercularis	Pars basilaris
Thalamus	Optic thalamus
Pallium	Cortex cerebri
Gyri transitivi	Annectant gyri
Fissura cerebri lateralis	Fissure of Sylvius
Gyrus temporalis superior	First temporal gyrus
Gyrus temporalis medius	Second temporal gyrus
Gyrus temporalis inferior	Third temporal gyrus
Sulcus centralis (Rolandi)	Fissure of Rolando
Sulcus temporalis superior	Parallel sulcus
Sulcus temporalis medius	Second temporal sulcus
Sulcus circularis	Limiting sulcus of Reil
Sulcus temporalis inferior	Occipito-temporal sulcus
Gyrus fusiformis	Occipito-temporal convolution
Sulcus interparietalis	Intraparietal sulcus
Sulcus corporis callosi	Callosal sulcus
Sulcus cinguli	Calloso-marginal fissure
Fissura hippocampi	Dentate fissure
Gyrus cinguli	Callosal convolution

B.N.A. Terminology.	Old Terminology.
Stria terminalis	Tænia semicircularis
Trigonum collaterale	Trigonum ventriculi
Hippocampus	Hippocampus major
Digitationes hippocampi	Pes hippocampi
Fascia dentata hippocampi	Gyrus dentatus
Columna fornicis	Anterior pillar of fornix
Septum pellucidum	Septum lucidum
Inferior cornu	Descending horn of lateral ventricle
Commissura hippocampi	Lyra
Nucleus lentiformis	Lenticular nucleus
Pars frontalis capsulæ internæ	Anterior limb (of internal capsule)
Pars occipitalis capsulæ internæ	Posterior limb (of internal capsule)
Radiatio occipito-thalamica	Optic radiation
Radiatio corporis callosi	Radiation of corpus callosum
Pars frontalis	Forceps minor
Pars occipitalis	Forceps major

Membranes of Brain.

Cisterna cerebello-medullaris	Cisterna magna
Cisterna interpeduncularis	Cisterna basalis
Granulationes arachnoideales	Pacchionian bodies
Tela chorioidea ventriculi tertii	Velum interpositum
Tela chorioidea ventriculi quarti	Tela choroidea inferior

Cerebral Nerves.

N. oculomotorius	Third nerve
N. trochlearis	Fourth nerve
N. trigeminus	Fifth nerve
Ganglion semilunare (Gasseri)	Gasserian ganglion
N. naso-ciliaris	Nasal nerve
N. maxillaris	Superior maxillary nerve
N. meningeus (medius)	Recurrent meningeal nerve
N. zygomaticus	Temporo-malar nerve
Rami alveolares superiores posteriores	Posterior superior dental
Rami alveolares superiores medii	Middle superior dental
Rami alveolares superiores anteriores	Anterior superior dental
Ganglion spheno-palatinum	Meckel's ganglion
N. palatinus medius	External palatine nerve
N. mandibularis	Inferior maxillary nerve
Nervus spinosus	Recurrent nerve
N. alveolaris inferior	Inferior dental
N. abducens	Sixth nerve
N. facialis	Seventh nerve
N. intermedius	Pars intermedia of Wrisberg
N. acusticus	Eighth or auditory nerve

B. N. A. Terminology.	Old Terminology.
Ganglion superius	Jugular ganglion of 9th nerve
N. recurrens	Recurrent laryngeal nerve
Ganglion jugulare	Ganglion of root } of vagus
Ganglion nodosum	Ganglion of trunk } of vagus
Plexus œsophageus anterior }	Plexus gulæ
Plexus œsophageus posterior }	
Nervus accessorius	Spinal accessory
Ramus internus	Accessory portion of spinal accessory nerve
Ramus externus	Spinal portion

Spinal Nerves.

Rami posteriores	Posterior primary divisions
Rami anteriores	Anterior primary divisions
N. cutaneus colli	Superficial cervical nerve
Nn. supraclaviculares anteriores	Suprasternal nerves
Nn. supraclaviculares medii	Supraclavicular nerves
Nn. supraclaviculares posteriores	Supra-acromial nerves
N. dorsalis scapulæ	Nerve to the rhomboids
Nn. intercosto-brachiales	Intercosto-humeral nerve
N. thoracalis longus	Nerve of Bell
N. thoraco-dorsalis	Long subscapular nerve
N. cutaneus brachii medialis	Lesser internal cutaneous nerve
N. cutaneus brachii lateralis	Cutaneous branch of circumflex nerve
Fasciculus lateralis	Outer cord (of plexus)
Fasciculus medialis	Inner cord
N. cutaneus antibrachii lateralis	Cutaneous branch of musculo-cutaneous nerve
N. cutaneus antibrachii medialis	Internal cutaneous nerve
Ramus volaris	Anterior branch
Ramus ulnaris	Posterior branch
N. cutaneus antibrachii dorsalis	External cutaneous branch of musculo-spiral
N. axillaris	Circumflex nerve
N. interosseus volaris	Anterior interosseous
Ramus palmaris N. mediani	Palmar cutaneous branch of the median nerve
Nn. digitales volares proprii	Collateral palmar digital branches of median nerve
Ramus dorsalis manus	Dorsal cutaneous branch of ulnar nerve
Ramus cutaneus palmaris	Palmar cutaneous branch of ulnar nerve
N. radialis	Musculo-spiral nerve
N. cutaneus brachii posterior	Internal cutaneous branch of musculo-spiral nerve
N. cutaneus antibrachii dorsalis	External cutaneous branches of musculo-spiral nerve

B.N.A. Terminology.	Old Terminology.
N. radialis (*contd.*)—	Musculo-spiral nerve (*contd.*)—
Ramus superficialis	Radial nerve
N. interosseus dorsalis	Posterior interosseous nerve
Nn. digitales dorsales	Dorsal digital nerves
N. ilio-hypogastricus	Ilio-hypogastric nerve
Ramus cutaneus lateralis	Iliac branch of ilio-hypogastric nerve
Ramus cutaneus anterior	Hypogastric branch of ilio-hypogastric nerve
N. genito-femoralis	Genito-crural nerve
N. lumbo-inguinalis	Crural branch of genito-crural nerve
N. spermaticus externus	Genital branch of genito-crural nerve
N. cutaneus femoris lateralis	External cutaneous nerve
N. femoralis	Anterior crural nerve
N. saphenus	Long saphenous nerve
Ramus infrapatellaris	Patellar branch of long saphenous nerve
N. ischiadicus	Great sciatic nerve
N. peronæus communis	External popliteal nerve
Ramus anastomoticus peronæus	Nervus communicans fibularis
N. peronæus superficialis	Musculo-cutaneous nerve
N. peronæus profundus	Anterior tibial nerve
N. tibialis	Internal popliteal nerve
N. cutaneus suræ medialis	Nervus communicans tibialis
N. suralis	Short saphenous nerve
N. plantaris medialis	Internal plantar
N. plantaris lateralis	External plantar
N. pudendus	Pudic nerve

THE HEART AND BLOOD VESSELS.

Heart.

Atrium	Auricle
Auricula cordis	Auricular appendix
Incisura cordis	Notch at apex of heart
Trabeculæ carneæ	Columnæ carneæ
Tuberculum intervenosum	Intervenous tubercle of Lower
Sulcus longitudinalis anterior	Anterior interventricular groove
Sulcus coronarius	Auriculo-ventricular groove
Limbus fossæ ovalis	Annulus ovalis
Valvula venæ cavæ	Eustachian valve
Valvula sinus coronarii	Valve of Thebesius

Arteries.

B.N.A. Terminology.	Old Terminology.
Sinus aortæ	Sinuses of Valsalva
A. profunda linguæ	Ranine artery
A. maxillaris externa	Facial artery
A. alveolaris inferior	Inferior dental artery
Ramus meningeus accessorius	Small meningeal artery
A. buccinatoria	Buccal artery
A. alveolaris superior posterior	Posterior dental artery
Aa. alveolares superiores anteriores	Anterior superior dental arteries
Ramus carotico-tympanicus	Tympanic branch of int. carotid
A. chorioidea	Anterior choroidal artery
A. auditiva interna	Auditory artery
Rami ad pontem	Transverse arteries (branches of Basilar artery)
A. pericardiaco-phrenica	Arteria comes nervi phrenici
Rami intercostales (A. mammaria interna)	Anterior intercostal arteries
Truncus thyreo-cervicalis	Thyroid axis
A. transversa scapulæ	Suprascapular artery
A. intercostalis suprema	Superior intercostal
A. transversa colli	Transversalis colli
A. thoracalis suprema	Superior thoracic artery
A. thoraco-acromialis	Acromio-thoracic artery
A. thoracalis lateralis	Long thoracic artery
A. circumflexa scapulæ	Dorsalis scapulæ
A. profunda brachii	Superior profunda
A. collateralis radialis	Anterior branch of superior profunda
A. collateralis ulnaris superior	Inferior profunda
A. collateralis ulnaris inferior	Anastomotica magna
Ramus carpeus volaris	Anterior radial carpal
Ramus carpeus dorsalis	Posterior radial carpal
Aa. metacarpeæ dorsales	Dorsal interosseous arteries
A. volaris indicis radialis	Radialis indicis
Arcus volaris superficialis	Superficial palmar arch
Arcus volaris profundus	Deep palmar arch
A. interossea dorsalis	Posterior interosseous artery
A. interossea recurrens	Posterior interosseous recurrent artery
A. interossea volaris	Anterior interosseous artery
Ramus carpeus dorsalis	Posterior ulnar carpal
Ramus carpeus volaris	Anterior ulnar carpal
Aa. digitales volares communes	Palmar digital arteries
Aa. digitales volares propriæ	Collateral digital arteries
Arteriæ intestinales	Intestinal branches of sup. mesenteric
A. suprarenalis media	Middle capsular artery
A. hypogastrica	Internal iliac artery
A. umbilicalis	Obliterated hypogastric
A. pudenda interna	Internal pudic artery
A. epigastrica inferior	Deep epigastric artery

B.N.A. Terminology.	Old Terminology.
A. spermatica externa	Cremasteric artery
Aa. pudendæ externæ	Superficial and deep external pudic arteries
A. circumflexa femoris medialis	Internal circumflex artery
A. circumflexa femoris lateralis	External circumflex artery
A. genu suprema	Anastomotica magna
A. genu superior lateralis	Superior external articular artery
A. genu superior medialis	Superior internal articular artery
A. genu media	Azygos articular artery
A. genu inferior lateralis	Inferior external articular artery
A. genu inferior medialis	Inferior internal articular artery
A. malleolaris anterior lateralis	External malleolar artery
A. malleolaris anterior medialis	Internal malleolar artery
A. peronæa	Peroneal artery
Ramus perforans	Anterior peroneal artery
A. malleolaris posterior lateralis	Posterior peroneal artery
A. malleolaris posterior medialis	Internal malleolar artery
Rami calcanei laterales	External calcanean artery
Rami calcanei mediales	Internal calcanean artery
A. plantaris medialis	Internal plantar artery
A. plantaris lateralis	External plantar artery
Aa. metatarseæ plantares	Digital branches
Aa. digitales plantares	Collateral digital branches

Veins.

V. cordis magna	Great cardiac vein
V. obliqua atrii sinistri	Oblique vein of Marshall
Lig. venæ cavæ sinistræ	Vestigial fold of Marshall
Vv. cordis minimæ	Veins of Thebesius
Sinus transversus	Lateral sinus
Confluens sinuum	Torcular Herophili
Plexus basilaris	Basilar sinus
Sinus sagittalis superior	Superior longitudinal sinus
Sinus sagittalis inferior	Inferior longitudinal sinus
Spheno-parietal sinus	Sinus alæ parvæ
V. cerebri internæ	Veins of Galen
V. cerebri magna	Vena magna Galeni
V. terminalis	Vein of the corpus striatum
V. basalis	Basilar vein
V. transversa scapulæ	Suprascapular vein
V. thoraco-acromialis	Acromio-thoracic vein
Vv. transversæ colli	Transversalis colli veins
V. thoracalis lateralis	Long thoracic vein
V. azygos	Vena azygos major
V. hemiazygos	Vena azygos minor inferior
V. hemiazygos accessoria	Vena azygos minor superior
V. hypogastrica	Internal iliac vein
V. epigastrica inferior	Deep epigastric vein
V. saphena magna	Internal saphenous vein
V. saphena parva	External saphenous vein

Lymphatics.

B.N.A. Terminology.	Old Terminology.
Cisterna chyli	Receptaculum chyli

THE VISCERA.

Digestive Apparatus.

Arcus glosso-palatinus	Anterior pillar of fauces
Arcus pharyngo-palatinus	Posterior pillar of fauces
Gl. lingualis anterior	Gland of Nuhn
Ductus submaxillaris	Wharton's duct
Gl. parotis accessoria	Socia parotidis
Ductus parotideus (Stenonis)	Stenson's duct
Dentes præmolares	Bicuspid teeth
Dens serotinus	Wisdom tooth
Papillæ vallatæ	Circumvallate papillæ
Recessus pharyngeus	Lateral recess of pharynx
Tela submucosa	Pharyngeal aponeurosis
Plicæ circulares	Valvulæ conniventes
Gl. intestinales	Crypts of Lieberkuhn
Valvula coli	Ileo-cæcal valve
Columnæ rectales	Columns of Morgagni
Plicæ transversales recti	Valves of Houston
Valvula spiralis	Valves of Heister
Noduli lymphatici aggregati (Peyeri)	Peyer's patches
Intestinum jejunum	Jejunum
Intestinum ileum	Ileum
Noduli lymphatici lienales (Malpighii)	Malpighian corpuscles

Respiratory Apparatus.

Larynx	
Prominentia laryngea	Adam's apple
Incisura thyreoidea superior	Superior thyroid notch
M. ary-epiglotticus	Aryteno-epiglottidean muscle
M. vocalis	Internal thyro-arytenoid muscle
M. thyreo-epiglotticus	Thyro-epiglottidean muscle
Appendix ventriculi laryngis	Laryngeal sac
Plica vocalis	True vocal cord
Plica ventricularis	False vocal cord
Ligamentum ventriculare	Superior thyro-arytenoid ligament
Ligamentum vocale	Inferior thyro-arytenoid ligament
Glottis	Glottis vera
Rima vestibuli	Glottis spuria
Cartilago thyreoidea	Thyroid cartilage

B.N.A. Terminology.	Old Terminology.
Membrana hyo-thyreoidea	Thyro-hyoid membrane
Cartilago corniculata (Santorini)	Cartilage of Santorini
Tuberculum epiglotticum	Cushion of epiglottis
Pars intermembranacea (rimæ glottidis)	Glottis vocalis
Pars intercartilaginea (rimæ glottidis)	Glottis respiratoria
Conus elasticus (membranæ elasticæ larynges)	Crico-thyroid membrane
Glandula thyreoidea	Thyroid gland
Glomus caroticum	Intercarotid gland or body
Nose	
Concha nasalis suprema (Santorini)	Highest turbinate bone
Concha nasalis superior	Superior turbinate bone
Concha nasalis media	Middle turbinate bone
Concha nasalis inferior	Inferior turbinate bone

Urogenital Apparatus.

Corpuscula renis	Malpighian corpuscles
Paradidymis	Organ of Giraldés
Appendix testis	Hydatid of Morgagni (male)
Ductus deferens	Vas deferens
Gl. urethrales	Glands of Littré
Glandula bulbo-urethralis (Cowperi)	Cowper's gland
Folliculi oophori vesiculosi	Graafian follicles
Cumulus oophorus	Discus proligerus
Tuba uterina	Fallopian tube
Epoophoron	Parovarium
Appendices vesiculosi	Hydatids of Morgagni (female)
Ductus epoophori longitudinalis	Gärtner's duct
Orificium internum uteri	Internal os (of uterus)
Orificium externum	External os
Processus vaginalis	Canal of Nuck
Glandula magna vestibuli	Bartholin's gland

Peritoneum.

Bursa omentalis	Lesser peritoneal sac
Foramen epiploicum	Foramen of Winslow
Lig. phrenico-colicum	Costo-colic ligament
Excavatio recto-uterina (cavum Douglasi)	Pouch of Douglas
Lig. gastro-lienale	Gastro-splenic omentum

SENSE ORGANS.

The Eye.

Sclera	Sclerotic coat
Lamina elastica anterior (Bowmani)	Bowman's membrane

B.N.A. Terminology.	Old Terminology.
Lamina elastica posterior (Descemeti)	Descemet's membrane
Spatia anguli iridis	Spaces of Fontana
Angulus iridis	Irido-corneal junction
Zonula ciliaris	Zonule of Zinn
Septum orbitale	Palpebral ligament
Fascia bulbi	Capsule of Tenon
Commissura palpebrarum lateralis	External canthus
Commissura palpebrarum medialis	Internal canthus
Tarsus superior	Superior tarsal plate
Tarsus inferior	Inferior tarsal plate
Lig. palpebrale mediale	Internal tarsal ligament
Raphe palpebralis lateralis	External tarsal ligament
Tarsal glands	Meibomian glands

The Ear.

Canalis semicircularis lateralis	External semicircular canal
Ductus reuniens	Canalis reuniens
Ductus cochlearis	Membranous cochlea
Recessus sphericus	Fovea hemispherica
Recessus ellipticus	Fovea hemi-elliptica
Paries jugularis	Floor of tympanum
Paries labyrinthica	Inner wall
Fenestra vestibuli	Fenestra ovalis
Fenestra cochleæ	Fenestra rotunda
Paries mastoidea	Posterior wall
Antrum tympanicum	Mastoid antrum
Paries carotica	Anterior wall
Processus lateralis	Processus brevis (of malleus)
Processus anterior	Processus gracilis

MANUAL

OF

PRACTICAL ANATOMY.

THE SUPERIOR EXTREMITY.

Introduction.—The superior extremity consists of the *brachium* or arm, which extends from the shoulder to the elbow; the *antibrachium* or forearm, which lies between the elbow and the wrist; the *wrist*, which connects the forearm with the hand; and the *manus* or hand. Belonging to it also are the bones of the shoulder girdle, the clavicle and scapula, by means of which it is articulated with the skeleton of the trunk; it is also attached to the trunk by means of a number of muscles. The angle which lies between the arm and the upper part of the trunk is the axilla or armpit.

Surface Anatomy.—Before commencing the actual dissection of any region of the body the student should be quite familiar with the bones of the region, for they are the landmarks by means of which the positions of the soft parts which lie beneath the skin can be defined, both in the dead and in the living body. The outlines of many of the bones and the projecting parts of others can be seen, for they cause prominences on the surface. Many portions of bone which cannot be seen can be felt quite easily when the finger is passed lightly over the places where they lie; slight pressure must be used in other places where the bones lie more deeply. Some parts of the skeleton, however, can be neither seen nor felt until the soft parts have been removed.

It is essential, therefore, that the student should train his eyes to see all that can be seen, and his fingers to feel all that can be felt, and he must remember that anything which he can see or feel in the case of the body of another person he can almost equally well see and feel in the case of his own body.

The bones of the superior extremity are the *clavicle* (collar bone) and the *scapula* (shoulder blade), the *humerus*, the *radius* and the *ulna*, *eight carpal bones*, *five metacarpal bones*, and *fourteen phalanges* (Figs. 1, 2, 3).

The scapula and clavicle, together, form the shoulder girdle, by means of which the arm is articulated with the skeleton of the trunk.

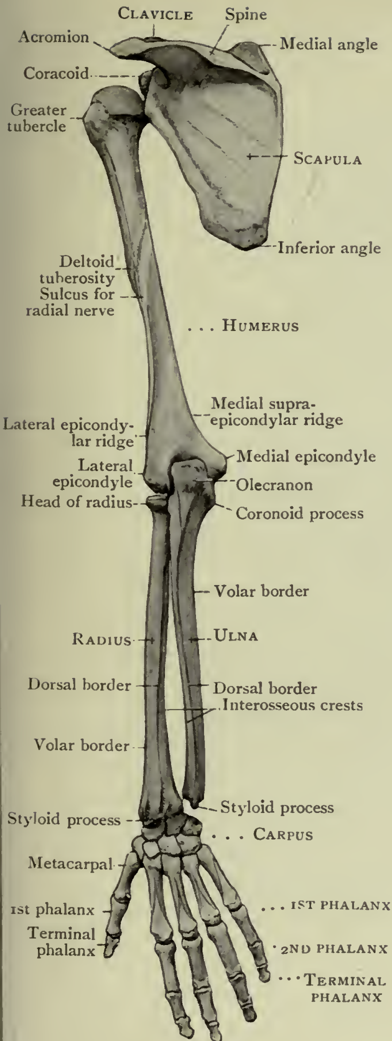
The clavicle can be seen and felt at the lower part of the front of the neck. It extends from the shoulder to the upper end of the sternum (breast bone), which lies in the middle part of the front of the chest. Below the junction of its intermediate and lateral thirds is a depression of the surface, the *delto-pectoral triangle*. The soft prominence to the medial side of the delto-pectoral triangle is caused by the portion of the pectoralis major muscle which is attached to the front of the medial half of the clavicle, and the prominence on the lateral side of the triangle is due to the anterior part of the deltoid muscle which springs from the front of the lateral third of the clavicle. If the finger is pressed upwards and backwards at the upper part of the lateral margin of the delto-pectoral triangle, a prominence of bone called the *coracoid process* of the scapula will be felt. It lies under cover of the medial edge of the deltoid muscle, and is an important landmark (Figs. 1, 2, 55, 56, 57).

Beyond and behind the lateral end of the clavicle a more or less quadrangular plate of bone can be felt. It is the *acromion* of the scapula. Its medial margin articulates with the lateral end of the clavicle, at the *acromio-clavicular joint*. Its lateral margin lies at the *tip of the shoulder*, and it is the upper point from which the length of the superior extremity is measured.

On the posterior aspect of the body running, medially, backwards and slightly downwards, from the acromion is a prominent and easily felt ridge of bone. It is the posterior border or *crest of the spine of the scapula*.

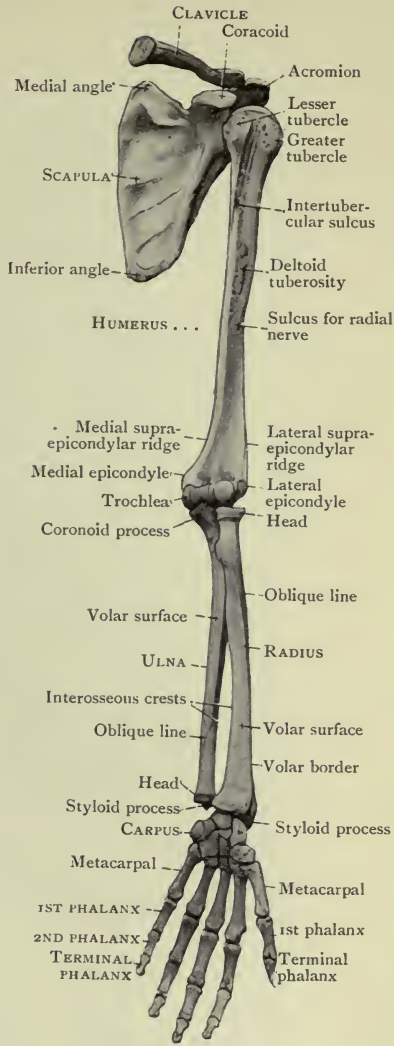
In the arm there is one bone, the *humerus*. It extends

PLATE I



A

Fig. 1.—Bones of Upper Limb. Posterior view.



B

Fig. 2.—Bones of Upper Limb. Anterior view.

PLATE II

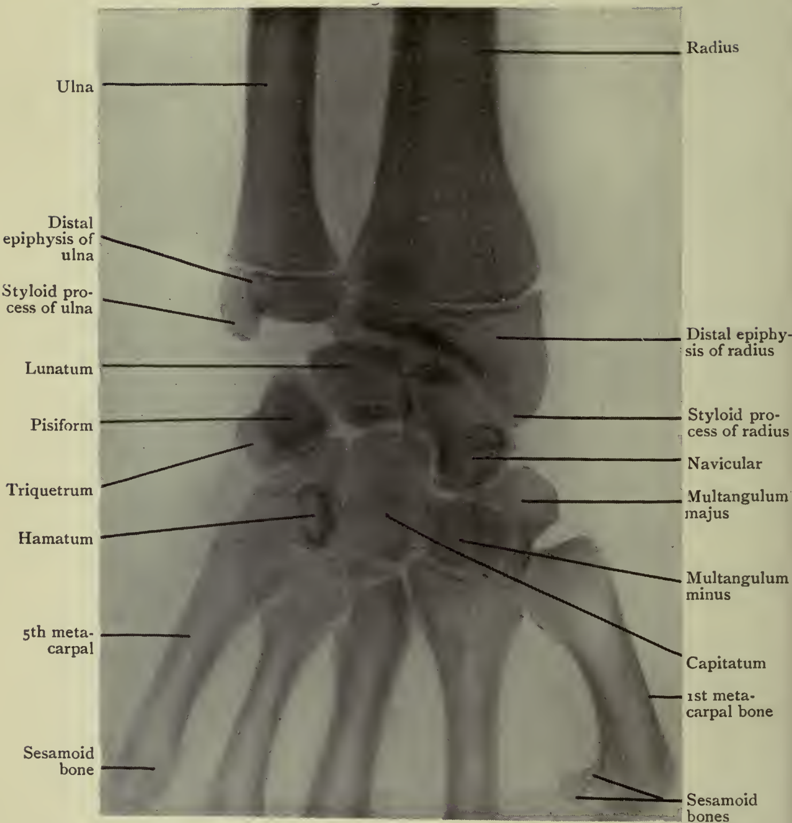


FIG. 3.—Antero-posterior Radiograph of the Wrist of a person of 19 years.

Note (1) The epiphyseal lines of the radius and ulna.
(2) The difference in level of the styloid process of the ulna as contrasted with the styloid process of the radius.
(3) The overlap of the shadows of adjacent bones.

from the shoulder, where it articulates with the scapula, to the elbow, where it articulates with the bones of the forearm; they are the *radius* on the thumb or lateral side, and the *ulna* on the medial or little finger side.

When the fingers are placed on the lateral side of the arm immediately below the acromion and the arm is moved in any direction, the proximal end of the humerus can be felt moving under cover of the deltoid muscle; the part of the humerus which is felt is mainly *the greater tubercle* (Figs. 1, 2, 55, 56).

The angular interval between the proximal part of the arm and the chest wall is the *axilla.* It contains important blood-vessels, nerves, and lymph glands. If the fingers are pushed well up into the axilla and the arm is moved, the lower part of the rounded head of the humerus, which articulates with the scapula, can be felt. In front of the fingers will be the anterior wall of the axilla, formed almost entirely by muscle; behind them will be the posterior wall, formed by muscles and by the axillary border of the scapula, which can be felt. To the medial side are the upper ribs of the chest wall, covered by a muscle called the *serratus anterior*; and laterally is the humerus.

The student should follow the body or shaft of the humerus from its proximal to its distal end, squeezing the soft parts between his thumb and fingers; as the region of the elbow is approached he will find that the humerus expands greatly from side to side and that its medial and lateral margins terminate in projections, which are called the *epicondyles of the humerus* (Figs. 1, 2, 85).

Both are landmarks. Behind the *medial epicondyle* lies the ulnar nerve; it can be felt quite easily in the living body if a finger is pressed against the back of the epicondyle and is moved from side to side. If the pressure is sufficiently strong it gives rise to a tingling sensation along the medial part of the hand.

Anterior to the *lateral epicondyle* and somewhat to its medial side another large nerve, the *radial*, breaks up into its terminal branches; it cannot, however, be felt.

The *posterior border of the ulna* is subcutaneous in the whole of its length. It extends from the *olecranon*, which is the prominence at the back of the elbow, to a small pointed process called the *styloid process of the ulna* which lies at the medial side of the back of the wrist (Figs. 1, 2, 3, 97, 98, 99).

Just lateral to the styloid process and slightly proximal to it there is a rounded piece of bone called the *head of the ulna*. It is best seen and felt when the palm of the hand is turned downwards.

The radius is more deeply buried than the ulna, but there is no difficulty in locating its proximal and distal ends. The proximal end, called the *head of the radius*, lies a short distance distal to the lateral epicondyle of the humerus. Its position is marked on the back of the forearm by a dimple of the skin. If a finger is placed in the dimple the head of the radius can be felt rotating when the palm of the hand is turned alternately upwards and downwards.

The distal end of the radius is the quadrangular mass of bone which can be felt at the lateral side and the back of the wrist. It lies lateral to the head of the ulna and it terminates on the lateral side in a pointed process, the *styloid process of the radius*.

The *eight carpal bones* of the wrist lie in the interval between the styloid processes of the radius and ulna, beyond which they extend distally for a short distance (Figs. 3, 67, 77).

The *five metacarpal bones of the hand*, one for each digit, extend from the carpus to the phalanges.

They are numbered one to five from the thumb to the little finger side, and all are easily felt at the back of the hand, where the heads or distal ends form the prominences known as the "knuckles."

The *fourteen phalanges* are in the free parts of the digits: two in the thumb, *first* or proximal and *second* or distal; three in each finger, proximal or *first*, middle or *second*, and distal or *third*. The second phalanx of the thumb and the third phalanges of the fingers are frequently called terminal phalanges.

The structures connected and associated with all the bones mentioned have to be examined by the dissector of the superior extremity, and whilst waiting to commence the dissection the dissector should verify all the points above mentioned upon his own body with the aid of his fingers and a looking-glass.

Since many students commence dissecting before they have attended either lectures or demonstrations on Anatomy, they are unacquainted with terms which must be used in the instructions given regarding the dissections which are to be made. Fortunately most of the terms used, like those already mentioned, refer to things which can be seen and felt; they, therefore, are easily understood. There are, however, certain terms, used when branches of spinal nerves are under consideration, which are not self-explanatory, and it is necessary, therefore, that the student should possess a knowledge of the terms used in connection with spinal nerves and their branches before the actual work of dissection is commenced. The following points should be noted: (1) Every spinal nerve is attached to the spinal medulla (spinal cord) by two roots, an *anterior root* and a *posterior root.* The anterior root is *non-ganglionated* and the posterior root is *ganglionated.* (2) As the roots are leaving the vertebral canal, through an intervertebral foramen, they unite to form a *trunk.* (3) Immediately after its exit from the intervertebral foramen the trunk divides into a *posterior ramus* and an *anterior ramus* of which the anterior ramus is, with few exceptions, much the larger. (4) Each posterior ramus divides into a *medial branch* and a *lateral branch.* (5) Each anterior ramus divides into a *lateral branch* and an *anterior branch* (Fig. 4).[1]

Every anterior root consists of nerve fibres which spring from nerve cells in the spinal medulla and pass to the muscle fibres of various muscles. They carry motor impulses to the muscles. Each posterior root consists of nerve fibres passing to and from the nerve cells of the ganglion of the posterior root. The posterior root fibres carry sensory impulses, such as cold, heat, pain, etc. The sensory impulses pass through the cells of the ganglion of the posterior root and then onwards to the spinal medulla.

The trunk of every spinal nerve, therefore, contains both *motor* or *efferent* and *sensory* or *afferent nerve fibres*, and the posterior and anterior rami into which it divides also contain both sets of fibres. The branches of the rami may contain either both sets of fibres or only one or the other set. Eventually, however, the peripheral parts of the fibres conveying impulses from and those conveying impulses to the spinal medulla separate from one another. The fibres which convey impulses from the spinal medulla become the motor nerves which end in the muscle fibres, whilst the fibres which

[1] This division is not always obvious, and in certain situations the lateral and anterior branches are called, respectively, posterior and anterior branches.

convey sensory impulses only are the sensory nerve fibres. The sensory nerve fibres which convey sensory impulses from the skin are termed *cutaneous nerves.*

The dissector of the upper extremity must begin work on

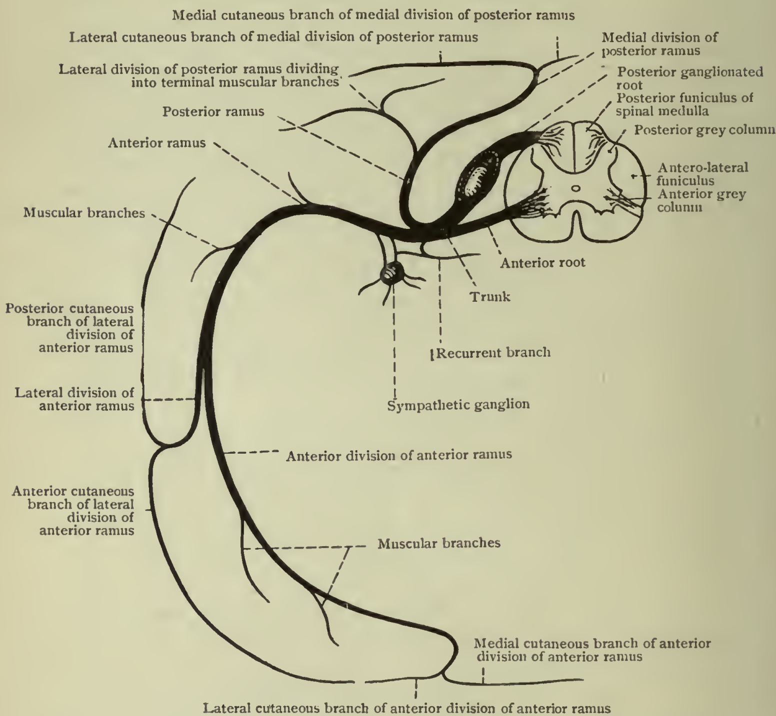


FIG. 4.—Diagram of a Spinal Nerve. Note that the medial divisions of the posterior ramus is represented as distributed to skin, whilst the lateral division terminates at a deeper level in muscle. In some situations the reverse condition occurs, and the medial and lateral divisions of all posterior rami supply muscles.

the fourth day after the subject has been placed in the dissecting-room. He will find the body lying upon its back. The thorax will be raised to a convenient height by means of blocks, and a long board will be placed under the shoulders for the purpose of supporting the arms when they are abducted from the sides.

Until the dissection of the axilla is completed the dissectors of the arm and of the head and neck will find it advantageous to arrange to work at different hours. The dissector of the head and neck, at this stage, is engaged on the posterior triangle of the neck, and the dissection of the triangle cannot be well done unless the arm is placed close to the side and the shoulder depressed. For the dissection of the axilla the arm should be stretched out at right angles to the thorax. A compromise between these two positions always results in discomfort to both dissectors.

Five days are allowed for the examination of the axilla and the muscles which pass to the upper extremity from the anterior portion of the thoracic region of the body. The following table will be found useful in regulating the amount of work which should be carried out on each day:—

First Day.—(*a*) Surface anatomy; (*b*) reflection of the skin; (*c*) cutaneous vessels and nerves of the anterior and lateral aspects of the thorax; (*d*) examination of the fascia of the pectoralis major and the axillary fascia; (*e*) the cleaning of the pectoralis major; (*f*) the reflection of the pectoralis major.

Second Day.—(*a*) The examination of the costo-coracoid membrane and the structures piercing it; (*b*) the removal of the costo-coracoid membrane and the examination of the structures posterior to it.

Third Day.—(*a*) The cleaning of the pectoralis minor; (*b*) the cleaning of the contents of the axilla below the pectoralis minor.

Fourth Day.—(*a*) The reflection of the pectoralis minor; (*b*) the completion of the cleaning of the contents of the axilla; (*c*) the cleaning of the serratus anterior; (*d*) the cleaning of the posterior wall of the axilla; (*e*) the reflection of the subclavius; (*f*) the examination of the sterno-clavicular articulation and the disarticulation of the clavicle at the sterno-clavicular joint.

Fifth Day.—(*a*) The brachial plexus and a general review of the axilla and its contents.

Before commencing the dissection of the axillary region draw your finger along the clavicle from its sternal to its acromial end. Note that in the medial two-thirds of its length the bone curves forwards to give room for the passage of vessels and nerves from the neck to the axilla. The lateral third is curved backwards. Place your finger in the delto-pectoral triangle below the junction of the intermediate and lateral thirds of the clavicle, and note that the great pectoral muscle lies to its medial side and the deltoid muscle to its lateral side; both muscles spring from the anterior aspect of the clavicle (see Fig. 10). Push your finger upwards and backwards in the triangle under the medial border of the deltoid until the coracoid process is distinctly felt. Next examine the articulations of the clavicle. Little or no prominence is formed by the lateral extremity of the bone—its superior surface lies in the same plane as the superior surface of the acromion of the scapula. When the upper limb is moved, however, the joint can easily be detected. In strong contrast to the inconspicuous acromio-clavicular joint is the sterno-clavicular joint, where the medial end of the clavicle can be felt as a marked projection, although it is masked, to the eye, by the sternal part of the sterno-cleido-mastoid muscle which causes the ridge-like prominence at the side of the neck as it extends from the sternum and clavicle to the skull behind the ear. Place the index finger in the *jugular notch* on the upper border of the manubrium sterni, between the clavicles, and carry it downwards, along the middle of the sternum, in the interval between the attachments of the great pectoral muscles. The portion of the sternum uncovered by the two greater pectoral muscles is narrow above, but it widens out below, and as the finger passes along it a prominent ridge will be felt. The ridge marks the junction of the manubrium sterni with the body of the sternum, and also the level at which the costal cartilages of the second ribs join the sternum. It is easily felt and can often be seen. It is, therefore, an excellent landmark, indicating the positions of the second pair of ribs, from which the counting of the other ribs should always commence. At the lower end of the body of the sternum, the finger, as it is carried downwards, will sink suddenly into a depression, between the cartilages of the seventh pair of ribs, and rest against the xiphoid process of the sternum. The depression is termed the *infrasternal fossa*, or pit of the stomach. The costal arches, below the first, are easily recognised, but the first rib lies deeply under the clavicle, and can be felt only in front, at its junction with the manubrium sterni. The arm should now be abducted (*i.e.* carried laterally from the trunk), when the hollow of the axilla and the two rounded folds, which bound it in front and behind, will be brought into view. The anterior fold of the axilla is formed by the lower border of the pectoralis major, and to a small extent also by the lower border of the pectoralis minor. The posterior fold, which is formed by the latissimus dorsi as it winds round the teres major muscle, is carried downwards to a lower level than the anterior fold. This, as will be seen later, is an important point in connection with the anatomy of the axilla. If the finger is pushed upwards into the axilla the globular head of the humerus will be felt, when the arm is rotated. One other point demands the attention of the student before the dissection is commenced, and that is the position of the nipple. As a rule it lies superficial to the interspace between the fourth and fifth ribs, and it is situated rather more than four inches from the median line.

The student should examine these various landmarks, not only upon the dead body but also upon himself and his friends, until he is perfectly familiar with them, both by touch and sight, and can at once put his finger on any given point, whatever the position of the limb may be.

Dissection.—Reflection of the Skin.—Incisions:—(1) Along the middle line of the body from the upper margin of the manubrium sterni to the tip of the xiphoid process. (2) Upwards and laterally from the tip of the xiphoid process to the nipple. At the nipple the incision must bifurcate, to encircle the dark patch of skin around the nipple which is called the areola, then it must be continued along the anterior fold of the axilla to the arm. As soon as it reaches the arm it must be carried downwards for about 63 mm. (two inches and a half), and then transversely to the lateral border of the arm. (3) From the tip of the xiphoid process transversely across the front and side of the chest to the plane of the posterior fold of the axilla (Fig. 5).

To make a clean incision in the skin place the point of the scalpel on one end of the line of incision, and, holding the scalpel at right angles to the surface to be incised, force the point through the skin till it enters the soft superficial fascia which lies beneath. Then incline the blade to an angle of 45° to the surface of the skin, and, pressing firmly on the back of the blade with the forefinger, carry it steadily to the opposite end of the line of incision, but as the end of the line is approached bring the blade again to a right angle with the surface, and so withdraw it from the incision.

To reflect the skin take hold of one of the angles of the flap marked out by the incisions with the forceps; in the case of the upper flap (1, Fig. 5), which should be dealt with first, the superior medial angle on the right side and the inferior medial angle on the left side, and with the edge of the scalpel detach it from the soft fat beneath.

As soon as the angle selected is sufficiently detached discard the forceps, and, holding the detached angle of skin between the thumb and forefinger of the left hand, keep it tense and draw the edge of the scalpel across the skin at its junction with the fat from one edge of the flap to the other, always keeping the edge of the knife against the skin. Be careful not to take any fat away with the skin. Continue the reflection until the lateral border of the shoulder region is reached. Leave the flap hanging along that border and turn to flap 2, Fig. 5. Commence at the medial angle, proceed as with flap 1, and continue the reflection until the posterior fold of the axilla is reached.

As the skin flaps are reflected towards the arm and the side of the chest the small patch around the nipple must be left untouched.

As that reflection proceeds note that the connection between the superficial fascia and the skin is stronger in some places than in others. In the female definite fibrous strands will be

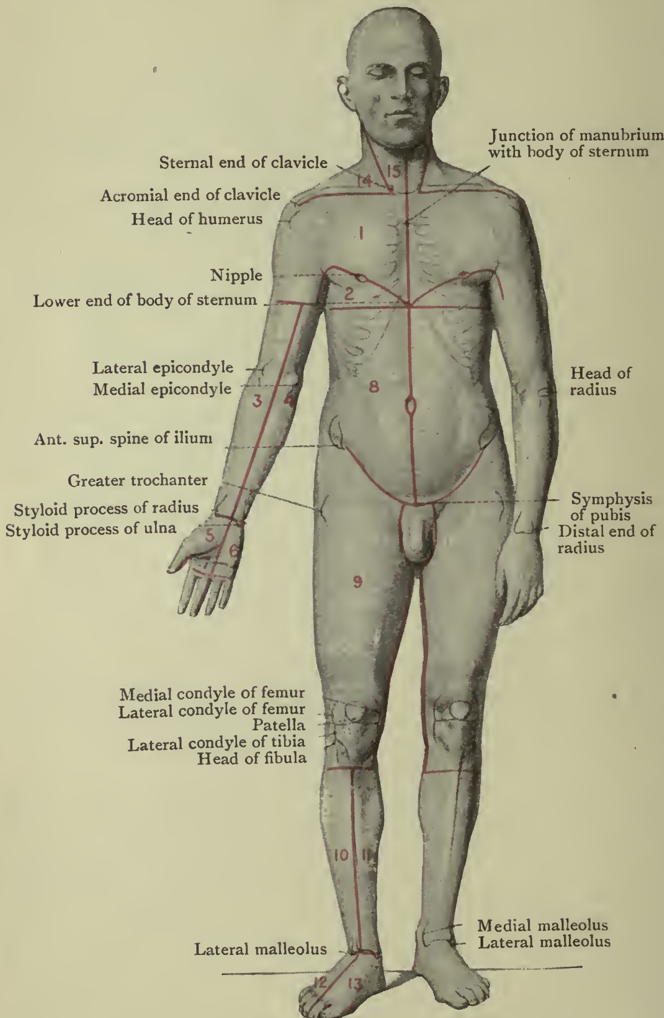


FIG. 5.—Surface view showing Incisions and Bony Points.

found passing from the substance of the mammary gland to the skin; they are called the *ligaments of Cooper*.

When the reflection of the flaps is completed the superficial fascia is exposed.

Superficial Fascia (Panniculus Adiposus).—The superficial fascia is found not only in the region now under consideration but over the whole of the body. Its structure is slightly different in different areas. In all parts, with the exception of the region of the scrotum, it contains yellowish fat, the amount of fat varying with the regions and with the obesity of the subject. In some regions muscle fibres of reddish tint are found in the deeper part of the superficial fascia; in the anterior part of the neck and the adjacent portion of the upper part of the chest they form, on each side, a definite sheet of muscle called the *platysma*; and in the region of the scrotum they entirely replace the fat.

In the superficial fascia lie the cutaneous vessels and nerves, and the deeper portions of the hairs and the sweat glands. In some regions the deeper parts of the sebaceous glands of the skin penetrate into it, and in the thoracic region, the *mammary glands*, which are modified subaceous glands, are developed in its substance. It contains also the superficial lymph glands.

Under cover of the superficial fascia and intervening between it and the muscles there is a more membranous layer of fibrous tissue called *deep fascia*.

The superficial fascia, therefore, intervenes between the skin and the deep fascia, and it is attached to both by fibrous strands which pass through the fat. As it lies between the skin and the deep fascia it forms a soft elastic cushion upon which the skin rests, and which, by its elasticity, allows the skin to be moved over the deeper parts. It rounds off the angularities of the body and it forms the bed in which the cutaneous vessels and nerves ramify before they enter the skin.

In the region at present exposed, the fat is not usually very plentiful except in female bodies, where it is abundant in the region of the mamma. In the neighbourhood of the clavicle a reddish striation due to the lower part of the platysma is usually visible, and if it is not seen the fibres of the muscle can be exposed quite easily by the removal of the thin layer of fat which lies superficial to them.

After the general characters of the superficial fascia have been noted the nerves and vessels which pass through it to the skin must be sought for. They are:—

Nervi Cutanei.
- Supraclavicular, from the cervical plexus.
- Anterior cutaneous } from the anterior (intercostal) rami of the thoracic
- Lateral cutaneous } nerves.

Arteriæ Cutaneæ.
- Cutaneous twigs from the branches of the thoraco-acromial artery:—
  - From the clavicular branch.
  - From the acromial branch.
  - From the deltoid branch.
- Perforating branches of the internal mammary artery.
- Branches form the lateral thoracic artery.
- Branches form the transverse scapular artery.

Dissection.—Cut through the superficial fascia to the deep fascia along the lateral margin of the sternum. The level of the deep fascia will be recognised by the increased resistance offered to the knife, and by its bluish-white colour when it is exposed. As regards the difference of resistance the dissector must educate his fingers to recognise the different "feel" of the various structures. As the edge of the knife touches them, superficial fascia, deep fascia, nerves, vessels, muscles, they all cause a different sensation, recognisable by the educated touch, which can only be acquired by attention and practice.

As soon as the level of the deep fascia is reached raise the cut margin of the superficial fascia with the forceps or fingers and, with the edge of the scalpel, sever the strands which attach the deep surface of the superficial fascia to the deep fascia, cutting against the deep fascia and removing the whole of the superficial fascia. As the separation proceeds pull the detached superficial fascia away from the sternum, and as soon as the anterior ends of the intercostal spaces are reached look for the *anterior cutaneous nerves* and the *perforating branches of the internal mammary artery*, which pierce the deep fascia near the margin of the sternum. If the arteries are well injected one should be found in each of the upper six intercostal spaces. It is not probable that a nerve will be found in the first space, but one should be found in each of the other five spaces. The arteries will be recognised by the red injection which they contain; each is accompanied by a small vein. The nerves are whitish threads, not unlike thin white thread. They are much firmer to the touch, and much stronger than the blood-vessels.

Trace both the vessels and nerves as far laterally as possible. When the anterior cutaneous nerves and the accompanying vessels have been secured look for the *supraclavicular nerves*; to find them cut through the fibres of the platysma along the upper border of the clavicle from the sternum to the shoulder, and turn the lower part of the severed muscle and fascia downwards, detaching it from the fascia beneath with the edge of the scalpel. As this is done look for the nerves which appear as whitish strands running downwards across the clavicle and passing from the deeper into the more superficial layer. Two or three should be found about the middle of the clavicle, one near its sternal end, and one near its acromial end descending in the fascia over the anterior part of the deltoid muscle. Follow the nerves downwards through the superficial fascia as far as possible; they descend to the level of the second or third rib, and are sometimes accompanied by small *branches of the transverse scapular artery* which pierce the deep fascia above the clavicle. Near the sternal end of the clavicle small twigs of the *clavicular branch of the thoraco-acromial artery* may be seen. Near the acromion twigs of the *acromial branch* of the same artery may be found; and in the delto-pectoral triangle twigs of the *deltoid branch* are occasionally visible.

After the supraclavicular nerves have been found and followed to their terminations cut through the superficial fascia along the line of the anterior fold of the axilla and the lower margin of the pectoralis major. As soon as the level of the deep fascia is reached turn the anterior part of the superficial fascia towards the median plane, and look for the *anterior branches of the lateral cutaneous nerves*, as they turn round the border of the pectoralis major, pierce the deep fascia, and run medially in the superficial fascia.

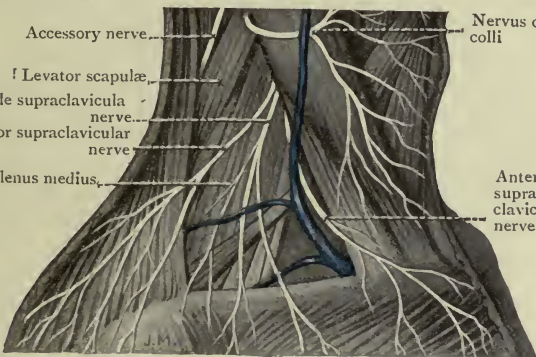


FIG. 6.—The Supraclavicular Branches of the Cervical Plexus.

Nervi supraclaviculares.—The *supraclavicular nerves* arise in the neck, from the third and fourth cervical nerves. They spread out as they descend, pierce the deep fascia of the neck, and they cross the clavicle under cover of the platysma. They are classified, according to their positions, into the anterior, the middle, and the posterior branches (Fig. 6). The *anterior* are the smallest of the series; they cross the medial part of the clavicle to end in the skin immediately below. The *middle branches* pass over the middle of the clavicle and extend downwards, in the superficial fascia over the pectoralis major, as far as the third rib. The *posterior* cross the lateral third of the clavicle, and will be afterwards followed to the skin of the shoulder. They are frequently accompanied by cutaneous branches of the transverse scapular artery.

Nervi Cutanei Anteriores.—The *anterior cutaneous nerves* are the minute terminal twigs of the anterior rami of the thoracic nerves. They become superficial by piercing the pectoralis major muscle and the deep fascia, close to the margin of the sternum. One will be found in each intercostal interval except the first; and they are accompanied by the *cutaneous perforating branches* of the internal mammary artery, which serve as the best guides to the nerves. The nerves and the arteries give slender twigs to the skin over the sternum, and larger branches which run laterally and may be traced as far as the anterior fold of the axilla. The cutaneous perforating artery which appears through the third intercostal space is usually the largest of the series, especially in the female.

Nervi Cutanei Laterales.—The *lateral cutaneous nerves*, much larger than the anterior, arise from the anterior rami of the thoracic nerves, and appear, on the side of the thorax, along a line situated a little behind the anterior fold of the axilla. They pierce the wall of the thorax in the interspaces between the ribs, and divide into anterior and posterior branches under cover of the serratus anterior muscle. At a later stage the branches will be found appearing between the digitations of the serratus anterior. The *anterior branches* appear, as a rule, about an inch in front of the corresponding posterior branches, and then pass forwards over the lower border of the pectoralis major muscle. From the lower members of this series some minute twigs are given off, which enter the superficial surfaces of the digitations of the external oblique muscle of the abdomen which will be exposed by the dissection of the abdomen. The *posterior branches* run backwards, to the dorsal aspect of the trunk, over the anterior border of the latissimus dorsi muscle (Fig. 16).

It is not advisable to attempt to secure the posterior branches of the lateral cutaneous nerves in the meantime. They are best dissected along with the other contents of the axilla.

The Mamma (Mammary Gland or Breast).—In the female the mamma forms a rounded prominence on the front and also, to some extent, on the lateral aspect, of the thorax. It lies *in* the superficial fascia, and its smooth contour is largely due to the invasion of its substance by the fatty tissue of that fascia.

A little below its mid-point, and at a level which usually corresponds to the fourth intercostal space, the mamma is surmounted by a conical elevation termed the *papilla mammæ* or nipple. The nipple stands in the middle of a circular patch of coloured skin which is called the *areola mammæ.*

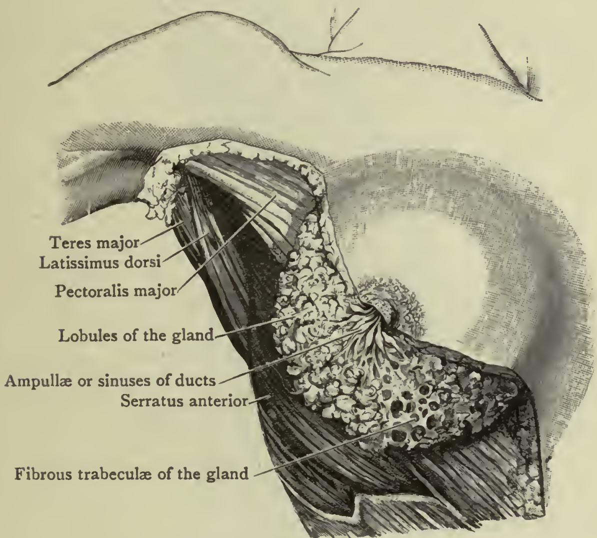


FIG. 7.—Dissection of the Mamma.

Within the nipple, and also subjacent to the areola, there is no fat. A curious change of colour occurs in this region in the female during the second month of pregnancy. At that time the delicate pink colour of the skin of the nipple and areola which was present in the virgin becomes converted to brown, by the deposition of pigment, and it never again resumes its original appearance.

The mamma extends, in a horizontal direction, from the side of the sternum almost to the mid-axillary line on the side of the thorax, and, in a vertical direction, from the second costal arch above to the sixth costal cartilage below. About two-thirds of the gland are placed upon the pectoralis major muscle, whilst the remaining part, which corresponds to its inferior and lateral third, extends beyond the anterior fold of the axilla, and lies upon the serratus anterior muscle. From the part which lies in relation to the lower border of the pectoralis major a prolongation extends upwards into the axilla, and reaches as high as the third rib.

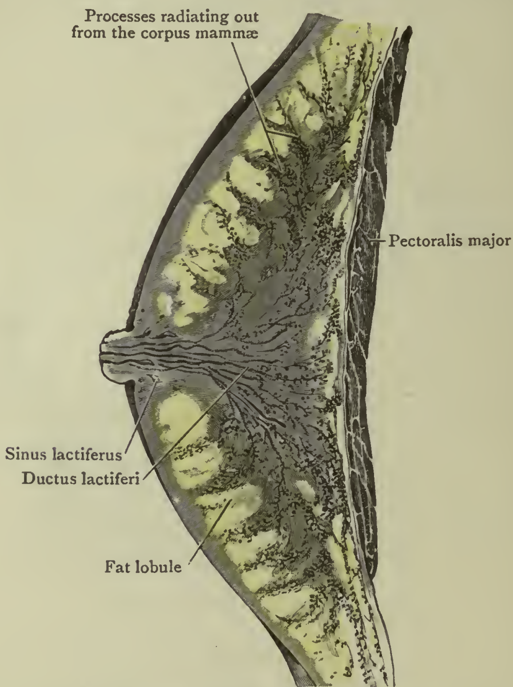


FIG. 8.—Section through a Mammary Gland prepared by the method recommended by Sir Harold Stiles.

The mamma is not enclosed in a capsule, and in that respect it differs from many other glands. Its lobules and lobes are embedded between strands of fibrous tissue which pass through the superficial fascia from the skin to the deep fascia. The strands form the stroma or framework of the gland. They support and bind together the various parts of the true glandular tissue, which consists of cell-lined tubes, and they attach the gland both to the skin and to the deep fascia. The strands which pass to the skin have been called the *ligaments of Cooper.*

The stroma and the gland tissue together form a conical mass called the *corpus mammæ.* From the surfaces and borders of the general mass of the corpus mammæ many processes of stroma and gland substance project, and in the hollows between the projections is deposited the fat upon which the smooth and rounded contour of the organ depends.

The portions of the tubes of the gland which form the secretion called milk are grouped together in smaller and larger masses, called lobules and lobes, in the interstices of the fibrous stroma of the gland. The portions of the tubes which carry the secretion towards the nipple are called ducts. The smaller ducts fuse with others to form larger ducts until finally some fifteen or more terminal ducts, called *lactiferous ducts*, converge towards the base of the nipple. Subjacent to the areola each duct expands into a fusiform dilatation called a *lactiferous sinus*, then it contracts, traverses the substance of the nipple, and opens on its apex (Figs. 7 and 8).

In a well-injected subject twigs from the *intercostal arteries*, and also from the *perforating branches* of the *internal mammary artery*, may be traced into the mamma; and other vessels, called the *external mammary branches* of the *lateral thoracic artery*, may be seen winding round the edge of the pectoralis major, or piercing its lower fibres, to reach the gland.

By means of lymph vessels which issue from it in the neighbourhood of the areola, and from its borders and its deep surface, the mammæ is connected with the axillary, the sternal and the infraclavicular lymph glands, and with the lymph vessels of the abdomen (Figs. 9, 14). The lymph vessels are not, as a rule, visible in an ordinary dissecting-room subject, for special methods of preparation are necessary for their proper display, but they must be remembered, because they are of the greatest importance in connection with the spread of any malignant disease which has commenced in the mamma.

In the male the mamma (mamma virilis) is quite rudimentary. The nipple is small and pointed, and the areola is surrounded by sparse hairs, which are never present in the female.

Dissection.—If the subject is a female the dissector should endeavour to make out some of the details described above. The strands called the ligaments of Cooper were noted, as the skin was removed from the surface of the gland (p. 17). Now the skin of the areola must be detached from the surface of the gland, and reflected towards the nipple. As that is done try to make out the lactiferous sinuses (Fig. 7) and the terminal ducts. If possible pass a bristle into one or other of the ducts at the apex of the nipple and trace the duct to a lactiferous sinus, and from the sinus trace the deeper part of the duct into the substance of the gland. Next, with the aid of the scalpel, gradually detach the gland from the deep fascia. Begin at the upper border, and, as the gland is displaced, note the strands of the stroma which connect its deep surface with the deep fascia. It is along those strands that blood-vessels and lymph vessels, which pierce the substance of the pectoralis major, enter and leave the gland. Trace a process of the lateral margin of the gland into the axilla behind the anterior axillary fold. Finally, remove the gland by cutting the mammary branches of the lateral thoracic artery at the lateral margin, and the mammary branches of the anterior perforating arteries at the medial margin, then examine the deep fascia of the pectoral and axillary regions.

Deep Fascia.—The deep fascia of the pectoral region is a thin membrane which closely invests the pectoralis major. It is attached above to the clavicle, and medially to the front of the sternum. Below, it is continuous with the deep fascia covering the abdominal muscles, and, at the lower border of the pectoralis major muscle, it is continuous with the axillary fascia. At the delto-pectoral triangle a process from its deep surface dips in, between the deltoid and pectoralis major muscles, to join the costo-coracoid membrane, whilst, further laterally, it becomes continuous with the fascia covering the deltoid muscle. The costo-coracoid membrane will be described later (p. 24).

Fascia Axillaris.—The axillary fascia is a dense felted membrane which extends across the base of the axilla. It is continuous anteriorly with the deep fascia over the pectoralis major, posteriorly with the fascial sheaths of the latissimus dorsi and the teres major muscles, medially with the deep fascia on the surface of the serratus anterior, whilst laterally it is continuous with the deep fascia on the medial surface of the proximal part of the arm. It is drawn up towards the hollow of the axilla, and the elevation is due chiefly to the connection of its deep surface with the fascial sheath of the pectoralis minor, and partly to its attachment to the areolar tissue which fills the axillary space. In a well-injected subject a small artery, from the distal part of the axillary trunk, may be seen ramifying on the surface of the fascia.

Dissection.—Cut through the deep fascia along the sulcus between the pectoralis major and the deltoid, and display the *cephalic vein* (Figs. 31, 33) and the *deltoid branch of the thoraco-acromial artery* which accompanies it. "Clean" them by removing the loose fascia in which they are embedded. Follow both vessels upwards to the delto-pectoral triangle where they disappear under cover of the upper border of the pectoralis major.

In the delto-pectoral triangle look for the *delto-pectoral lymph glands* which are sometimes present. Lymph glands are rounded or ovoid masses of fairly dense tissue, which vary in colour; they may be yellowish-pink, rose-pink, reddish-brown, purple-brown, or in some regions quite black. Their surfaces are usually glistening, and attached to the borders and surfaces are many fine white vessels, the lymph vessels, which convey a fluid called lymph to and from the glands. Lymph glands vary very much in size, and the delto-pectoral glands may be as small as a pin-head or as large as a good-sized pea. After the contents of the delto-pectoral triangle have been studied, clean the anterior part of the deltoid and the whole of the pectoralis major muscle, and note the natural separation of the latter muscle into sternal and clavicular parts.

The "cleaning" of a muscle means the removal of the whole of the deep fascia from its surface. To do this successfully the dissector must follow three rules. (1) He must cut boldly down through the deep fascia till he exposes the red fibres of the muscle. (2) As he removes the fascia he must keep the knife edge playing against the fibres of the muscle. (3) As he makes his cuts he must carry the knife blade in the direction of the fibres of the muscle. If he follows rules 1 and 2 he will not leave a thin film of fascia on the muscle, and as he follows rule 3 he will find that the direction of his incisions changes as the course of the fibres of the muscle changes. If the work is well done the deep fascia should be removed from the muscle as a continuous unperforated layer of fibrous tissue, and the surface of the muscle will be clean.

To clean the anterior part of the deltoid, cut through the deep fascia along the anterior border of the muscle, and reflect the fascia until the base of the skin flap is reached. As the fascia is reflected some cutaneous twigs of the axillary nerve may be noted piercing the surface of the muscle, and filaments of the lateral cutaneous nerve of the arm will also be found (see Figs. 31, 32, 33).

To clean the pectoralis major commence at the upper border of the muscle on the right side, and at the lower border on the left side, reflecting the fascia in the first case downwards, and in the second upwards. Before the removal of the fascia is begun make the muscle tense by abducting the arm.

The delto-pectoral glands, sometimes represented by a single gland, receive lymph from the lateral side of the arm and from the shoulder by lymph vessels which accompany the cephalic vein, and they transmit it to lymph vessels which connect the delto-pectoral glands with the infraclavicular glands (see Figs. 9, 30).

M. Pectoralis Major.—The powerful pectoralis major muscle extends from the anterior aspect of the thorax to the humerus. It is divided by a deep fissure into a clavicular and

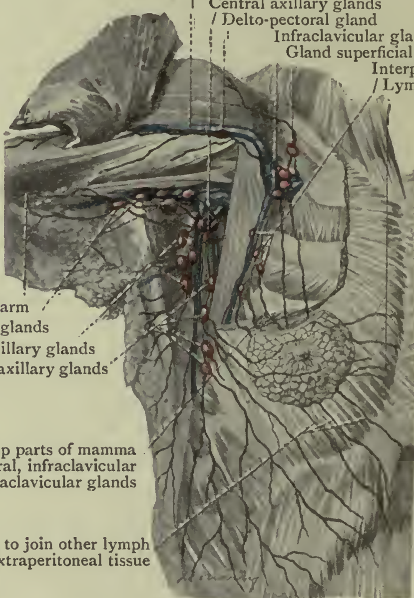


FIG. 9.—The Lymph Glands and Vessels of the Axilla and Mamma.

a sternocostal portion. The fissure penetrates through the entire thickness of the muscle, the clavicular and sternocostal portions being distinct, except close to their insertions. The *clavicular portion* arises by short tendinous and muscular fibres from an impression on the medial half of the anterior surface of the clavicle. The superficial part of the *sternocostal portion* takes origin, by fleshy fibres, (1) from the anterior surface of the sternum, (2) from the aponeurosis of the external oblique muscle, and (3) occasionally from the sixth rib near its cartilage. The deeper part arises by a variable number of muscular slips from the cartilages of the upper six ribs.

The muscle is inserted, by a flattened bilaminar tendon, into the lateral lip of the intertubercular sulcus of the humerus, and the fibres of the muscle undergo a rearrangement as they converge upon the tendon. The greater part of the clavicular portion joins the anterior lamina of the common tendon; some of the most medial clavicular fibres, however, are inserted directly into the humerus, distal to the tendon, whilst a few gain attachment to the deep fascia of the arm, and others become adherent to the adjacent part of the deltoid.

The fibres of the sternocostal portion of the muscle do not all pass in the same direction but they all join the laminæ

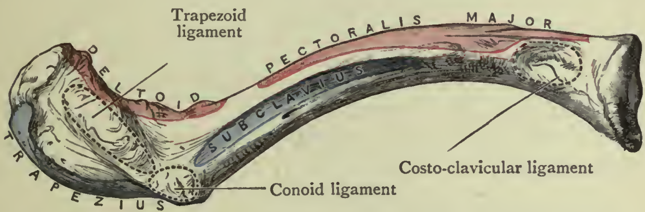


FIG. 10.—Inferior Surface of the Clavicle with the Attachments of the Muscles mapped out.

of the tendon of insertion. The superior fibres descend slightly, the intermediate fibres pass horizontally, whilst the inferior fibres ascend, and, at the same time, gain the deep surface of the rest of the muscle. A smooth, full, and rounded lower border of the muscle is thus formed; it constitutes the anterior fold of the axilla. The attachments of the muscle to the humerus will be studied in detail at a later stage of the dissection (p. 87).

The pectoralis major is supplied by the *medial* and *lateral anterior thoracic nerves*. It is an adductor of the superior extremity and a medial rotator of the humerus.

Axilla.—The axilla is the hollow or recess between the upper part of the side of the thorax and the proximal part of the arm. When the arm is abducted from the trunk, and the areolo-fatty tissue which occupies the axilla is removed, the space disclosed has the form of a four-sided pyramid. The apex, or narrow part of the space, lies immediately to the medial side of the coracoid process, and is directed upwards towards the root of the neck, whilst the wider part or base of the space looks downwards. The medial wall, formed by the thorax, is of greater extent than the lateral wall which is formed by the arm. It follows, therefore, that the anterior and posterior walls converge as they proceed laterally, and, because the posterior wall is longer, from above downwards, than the anterior, the posterior border of the base is lower than the anterior.

Before beginning the dissection of the space, the dissector should have a general knowledge of its boundaries and of the manner in which the contents are disposed in relation to the boundaries.

Boundaries of the Axilla.—The four walls of the axilla are (1) anterior, (2) posterior, (3) medial, and (4) lateral. The *anterior wall* is formed by the two pectoral muscles, the subclavius and the fascia which surrounds the pectoralis minor and attaches its upper border to the clavicle and its lower border to the floor of the axilla, and to the deep fascia on the medial side of the arm. The pectoralis major forms the superficial stratum, and is spread out over the entire extent of the anterior wall. The pectoralis minor lies posterior to the pectoralis major, and takes part in the formation of the middle third of the anterior boundary. The fascia which fills the gap between the pectoralis minor and the clavicle is called the costo-coracoid membrane; it splits above to enclose the subclavius muscle, and along the lower border of that muscle it is stronger than elsewhere. The lower border of the anterior wall is the *anterior fold* of the axilla. It is formed by the lower border of the pectoralis major, strengthened, medially, by the lower border of the pectoralis minor, which projects beyond the major near the side of the thorax.

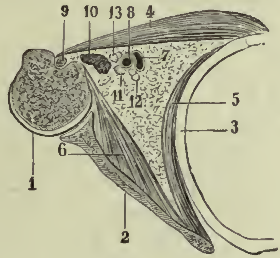
The *posterior wall* of the axilla is formed by the lateral part of the subscapularis muscle, by a portion of the latissimus dorsi and its tendon, and by the teres major muscle. The subscapularis covers the costal surface of the scapula. The latissimus dorsi winds from the back, round the medial part of the lower border of the teres major to gain its anterior surface; thus the lower border of the posterior wall, which constitutes the *posterior fold* of the axilla, is formed in its medial part by the latissimus dorsi, and laterally by the inferior margin of the teres major.

In the *medial wall* are parts of the upper five ribs with the intervening intercostal muscles; they are covered by the corresponding digitations of the serratus anterior muscle.

The *lateral wall* is formed by the humerus and the conjoined proximal parts of the coraco-brachialis and the short head of the biceps brachii muscles.

At the *apex* of the space is the narrow triangular interval through which the axilla communicates with the neck; it is frequently called the *cervico-axillary canal.* It is bounded anteriorly by the clavicle, medially by the outer border of the first rib, and posteriorly by the superior margin of the scapula; through it pass the axillary vessels and the big nerve cords of the brachial plexus on their way from the

1. Proximal end of humerus.
2. Scapula.
3. Rib.
4. Pectoralis major.
5. Serratus anterior.
6. Subscapularis.
7. Axillary vein.



8. Axillary artery.
9. Long head of biceps.
10. Conjoined origin of short head of biceps and coraco-brachialis.
11, 12, 13. Brachial nerves.

FIG. 11.—Diagram of section through the Axilla of the Left Side.

neck to the arm. The wide *base* or floor of the space is closed by the vaulted axillary fascia.

Contents of the Axilla.—The axillary artery and vein, with the large brachial nerves, which supply the superior extremity, and the axillary lymph vessels and lymph glands, are the most important contents of the axilla. They are all embedded in the soft axillary fat. Except at the apex of the space, the great vessels and nerves lie close to the lateral wall, and follow it in all the movements of the arm.

Dissection.—Cut through the clavicular fibres of the pectoralis major, immediately below their attachment to the clavicle, and turn them towards their insertion. At the same time, secure the branches of the lateral anterior thoracic nerve which pass into the deep surface of the muscle. Follow the cephalic vein and the deltoid branch of the thoraco-acromial artery medially, under cover of the clavicular part of the pectoralis major, and secure the acromial and pectoral branches of the latter artery. Clean those vessels and, directly below the clavicle, display the *costo-coracoid membrane*, and, more inferiorly and laterally, the fascia on the lateral part of the pectoralis minor. Cut through the sternocostal part of the pectoralis major about two inches from the lateral border of the sternum. Turn the medial part towards the median plane; verify its attachment to the costal cartilages and to the sternum and to the aponeurosis of the external oblique muscle of the abdomen. Turn the lateral part of the muscle towards the arm; whilst doing that, secure the medial anterior thoracic nerve, which perforates the pectoralis minor and ends in the pectoralis major. Examine the insertion of the pectoralis major. Note that the tendon of insertion consists of two laminæ which are united together below; in other words, the tendon is folded on itself; and between the two laminæ a *mucous bursa* is frequently interposed. The clavicular fibres and the upper sternocostal fibres are attached to the anterior lamina, the lower sternocostal fibres to the posterior lamina. Both laminæ are attached to the lateral lip of the intertubercular sulcus of the humerus, but the deep lamina ascends to a more proximal level, and becomes continuous with a layer of fascia which is attached to the lesser tubercle of the humerus. The inferior border of the tendon of insertion is continuous with the deep fascia of the arm.

When the pectoralis major is completely reflected a continuous sheet of fascia is exposed, which extends from the clavicle superiorly to the axillary fascia inferiorly, and from the wall of the thorax medially to the arm laterally; the sheet of fascia is the so-called *clavipectoral fascia* or *suspensory ligament of the axilla*. It is because of the attachment of that fascial sheet to the clavicle superiorly and to the axillary fascia inferiorly that the floor of the axilla is raised as the arm is abducted from the side and the clavicle is elevated. The pectoralis minor muscle, passing obliquely from its origin on the thoracic wall to its insertion into the coracoid process of the scapula, runs through the substance of the clavipectoral fascia and divides it into three parts: (1) the part above the muscle, (2) the part which encloses the muscle, and (3) the part below the muscle. The uppermost part is the costo-coracoid membrane, the intermediate part is the sheath of the pectoralis minor. No special term is applied to the lowest part, but it should be noted that it lies posterior to the lower part of the pectoralis major, and that it covers the distal portions of the axillary vessels and nerves.

Membrana Costocoracoidea.—The costo-coracoid membrane occupies the gap between the clavicle and the pectoralis minor. It extends from the first rib medially to the coracoid process laterally, and from the clavicle above to the pectoralis minor below. Its upper part is split into two layers, an anterior and a posterior, which are attached to the corresponding borders of the clavicle. Enclosed between them is the subclavius muscle. The strongest part of the membrane is that which extends along the lower border of the subclavius, from the first rib to the coracoid process; that portion is frequently called the *costo-coracoid ligament*. The membrane is continuous below with the fascial sheath of the pectoralis minor and posteriorly with the fascial sheath of the axillary vessels (Fig. 12). It is perforated, above the upper border of the pectoralis minor, by the cephalic vein, the thoraco-acromial vessels, and the lateral anterior thoracic nerve. Note (1) *that the fibres of the membrane run medio-laterally*, (2) *that they are put on the stretch when the arm is abducted*, and (3) *that they are relaxed when the arm is by the side.* The surgeon takes advantage of these facts when he is ligaturing the first part of the axillary artery.

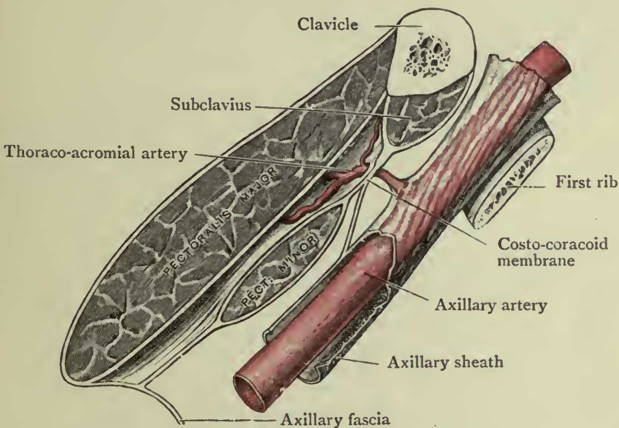


FIG. 12.—Diagram of the Costo-coracoid Membrane.

Dissection.—Cut through the anterior layer of the upper part of the costo-coracoid membrane and expose the subclavius muscle. Pass the handle of a knife below the lower border of the subclavius and upwards behind the muscle and demonstrate the posterior layer of the upper part of the membrane. Clear away the remains of the membrane and follow the cephalic vein to its junction with the axillary vein, the thoraco-acromial artery to the axillary trunk, and the lateral anterior thoracic nerve to the lateral cord of the brachial plexus. Clean the proximal parts of the axillary artery and vein and the lateral cord of the brachial plexus. Note that the axillary vein lies to the medial side of the artery, on a somewhat anterior plane, and that as the arm is abducted from the side the vein passes more and more in front of the artery. The lateral cord of the plexus lies to the lateral side of the artery and on a posterior plane. Behind the upper border of the pectoralis minor find the medial anterior thoracic nerve, and note that a communication is formed between the medial and lateral anterior thoracic nerves, across the front of the axillary artery and behind the costo-coracoid membrane.

Clean the pectoralis minor muscle without injuring the medial anterior thoracic nerve, which pierces it.

M. Pectoralis Minor.—The pectoralis minor muscle is triangular in outline. It arises (1) from the anterior ends of the third, fourth, and fifth ribs, close to their junctions with their cartilages, and (2) from the fascia covering the intercostal muscles in the intervening spaces. Its fibres pass upwards and laterally, and its tendon of insertion is attached to the upper surface and the antero-medial border of the horizontal part of the coracoid process, near its lateral extremity. When the muscle is in action it draws the scapula downwards and forwards, and depresses the shoulder. It is supplied by the *medial anterior thoracic nerve.* The greater portion of the pectoralis minor is concealed by the pectoralis major, but the lower and medial part of its inferior border appears on the lateral wall of the thorax below the pectoralis major; its insertion is concealed by the anterior fibres of the deltoid.

Dissection.—Clear away the clavipectoral fascia below the level of the pectoralis minor and open up the lower part of the axilla; remove also the deep fascia of the arm in the region of the lateral boundary of the axilla.

Commence at the lateral part of the area below the pectoralis minor and clean the coraco-brachialis and the short head of the biceps, as they descend into the arm from the tip of the coracoid process. Find the distal part of the axillary artery at the medial border of the coraco-brachialis. The trunk of the median nerve lies between the artery and the muscle, and at the lower border of the pectoralis minor the medial head of the nerve crosses the front of the artery. Pull the coraco-brachialis laterally and find the musculo-cutaneous nerve entering its deep surface, just below the pectoralis minor. Above and to the lateral side of the trunk of the musculo-cutaneous nerve find the branch from it which supplies the coraco-brachialis. The axillary vein lies along the medial side of the artery, and in the interval between the artery and vein, anteriorly, is the medial cutaneous nerve of the forearm (O.T. internal cutaneous). Running along the medial side of the vein is the medial cutaneous nerve of the arm (O.T. lesser internal cutaneous nerve); secure it and follow it upwards to the communication which it receives from the intercosto-brachial nerve (Fig. 13). At the same time identify and preserve the lateral group of axillary lymph glands, which lie along the medial side of the axillary vein. Secure the intercosto-brachial nerve and follow it medially, to the point where it emerges from the second intercostal space, and laterally to the medial and posterior aspect of the arm, where it is distributed.

In order to display the distribution of the intercosto-brachial nerve, and to give better access to the medial and posterior walls of the axilla, the axillary fascia must be separated from the fascia of the arm. When that has been done the dissector should turn to the medial wall of the axilla and find the anterior and posterior divisions of the lateral branches of the intercostal nerves, as they

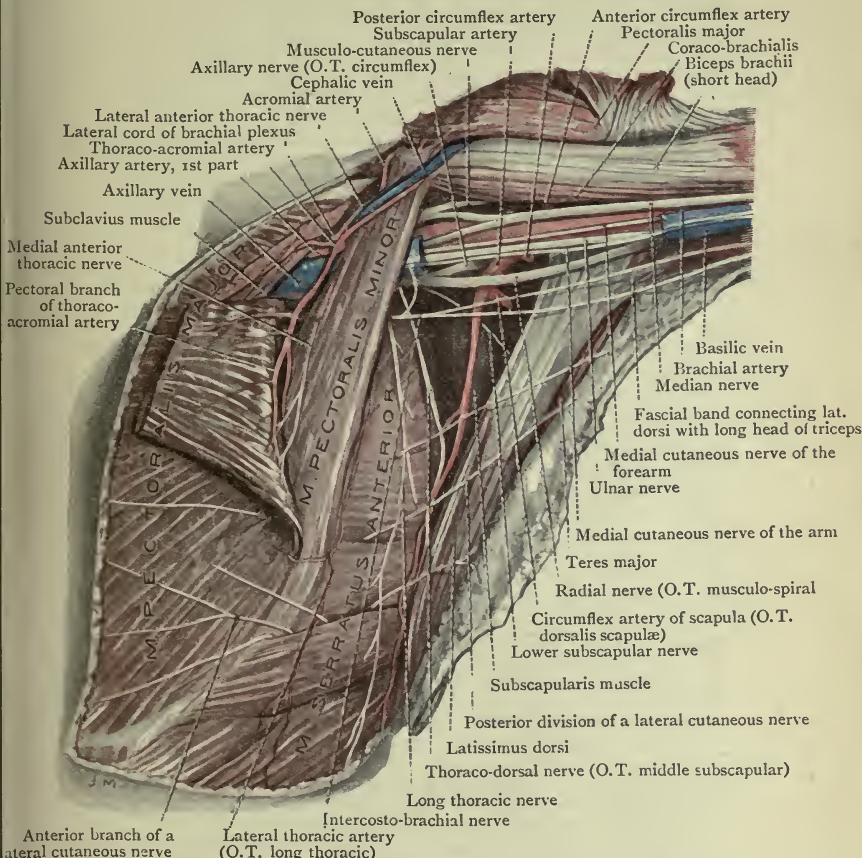


FIG. 13.—The contents of the Axillary Space exposed by the reflection of the Pectoralis Major and the subjacent fascia, and the removal of the fat and glands.

emerge between the digitations of the serratus anterior, behind the inferior border of the pectoralis minor. He must trace them forwards and backwards respectively, and he may expect to find communications between the posterior division of the third lateral branch and the intercosto-brachial nerve. At the junction of the anterior and medial walls of the axilla and at the lower border of the pectoralis minor, find the lateral thoracic artery ; clean the artery and the medial group of axillary lymph glands, which lie along its course.

At the junction of the posterior third and anterior two-thirds of the medial wall of the axilla find the long thoracic nerve, which supplies the serratus anterior and descends along its lateral surface, from the apex to the base of the axilla. After the nerve has been secured the serratus anterior must be cleaned. When that has been done the dissector should clean the distal parts of the large vessels and nerves and their branches and tributaries.

With chain and hooks pull the axillary artery and the medial cutaneous nerve of the forearm towards the arm and displace the axillary vein in the opposite direction ; then find the ulnar nerve which lies in the posterior part of the interval between the artery and vein ; pull the ulnar nerve laterally, and behind the artery find the large radial nerve (O.T. musculo-spiral). Pull it medially and follow its lateral border upwards. At the lower border of the subscapularis muscle on the lateral side of the radial nerve secure the axillary nerve as it turns backwards into the posterior wall of the axilla. Near the axillary nerve is the large subscapular branch of the axillary artery accompanied by the corresponding vein. The subscapular artery springs from the medial side of the axillary artery. A short distance below its origin it divides into two branches, the circumflex scapular and the thoraco-dorsal. The circumflex scapular passes backwards into the posterior wall of the axilla. The thoraco-dorsal artery descends along the lower border of the subscapularis muscle to the angle where the posterior wall joins the medial wall of the axilla. Follow the artery downwards, taking care not to injure the intercosto-brachial nerve and the posterior branches of the lateral rami of the 3rd, 4th, and 5th intercostal nerves which cross in front of it. Note the posterior group of axillary lymph glands which lie along its course, and near its lower end secure the thoraco-dorsal nerve, which crosses in front of the artery, on its way to the latissimus dorsi, which it supplies. Return to the division of the subscapular artery. Dissect in the angle between its circumflex scapular and its thoraco-dorsal branches and secure the second subscapular nerve, which supplies the teres major muscle ; follow it to the muscle.

Return to the radial nerve and find springing from its medial border near the lower margin of the subscapularis the posterior brachial cutaneous nerve, and branches to the long and medial heads of the triceps muscle. Not uncommonly all those branches are conjoined at their origin, and separate as they pass to their destinations. The posterior brachial cutaneous nerve, on its way to the middle of the posterior aspect of the arm, passes behind the intercosto-brachial nerve. The nerve to the long head of the triceps enters the proximal part of that muscle. There are usually two branches to the medial head of the triceps ; one enters the proximal part of the muscle, and the other, known as the *ulnar collateral*, because it runs by the side of the ulnar nerve, passes to the distal part. It will be traced to its termination at a later period.

The anterior and posterior humeral circumflex branches of the axillary artery will be found springing from the artery a short distance distal to the subscapular branch, the former arising from the anterior, and the latter from the posterior aspect of the axillary trunk.

After the lower part of the axilla has been thoroughly cleaned, the pectoralis minor must be divided, about midway between its origin and insertion, and the two parts must be turned aside. When that has been done the upper subscapular nerve must be found as it enters the upper part of the subscapularis, and then the remaining areolar tissue must be removed from the axillary space, the trunks and branches of the axillary vessels and nerves must be thoroughly cleaned, and the contents of the space must be studied in detail.

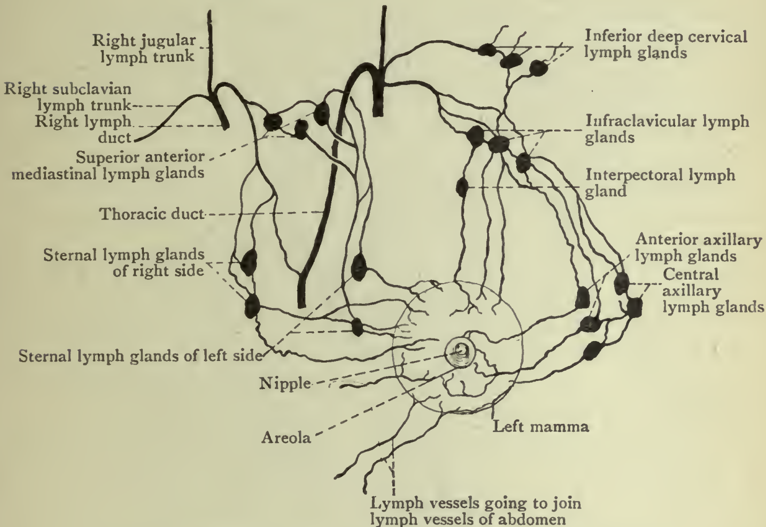


FIG. 14.—Diagram of the Connections of the Lymph Vessels of the Mamma.

Lymphoglandulæ Axillares (Axillary Lymph Glands).—The lymph glands in the axillary region are spoken of, collectively, as the axillary glands, but for convenience of description, and to facilitate a more precise knowledge of their connections and associations, they are subdivided into several subordinate groups. Some of the glands have been removed as the dissection proceeded, and others are so small that they may have escaped the attention of the dissector; but if he has followed the directions given above he will have noted at least four groups of glands. (1) A lateral or brachial group consisting of six or more glands, which lie along the axillary vessels. They receive the lymph vessels from the greater part of the upper extremity, and those at the upper part of the chain also receive lymph from the deep part of the mamma. (2) A pectoral group, or anterior group, which lies in the angle between the anterior and medial walls of the axilla. This is subdivisible into two parts: (*a*) an upper group of two or three small glands which lie behind the pectoralis major in the region of the second and third intercostal spaces—these receive lymph from the anterior wall of the thorax and from the lateral two-thirds of the mamma; (*b*) an inferior group which lies along the posterior border of the lateral thoracic artery, and receives lymph from the lateral wall of the thorax. (3) A posterior or subscapular group, which lies along the subscapular artery on the posterior wall of the axilla, and receives lymph vessels from the back. (4) The delto-pectoral glands, a group of two or three small glands which lie in the delto-pectoral triangle and receive lymph from the proximal and lateral parts of the arm.

In addition to the lymph glands which are usually seen in an ordinary dissection, there are three other groups of glands. (*a*) *Inter-pectoral glands*, from one to three or four, which lie on the anterior surface of the pectoralis minor; they receive lymph from the deep part of the mamma by lymph vessels which pierce the pectoralis major. (*b*) The *central glands*, which are very variable; they lie either on the surface of the axillary fascia, in a pocket of its substance, or deep to it in the fat of the middle part of the axilla; they have no afferents from any definite region, but are connected with the other groups. (*c*) The *infraclavicular glands*, which lie in the apex of the axilla behind the costo-coracoid membrane. They receive efferents from all the lower groups, and their efferents unite to form a subclavian lymph trunk which terminates on the left side in the *thoracic duct*, and on the right side in the right *lymph duct* (Fig. 14).

Rami Laterales (O.T. **Lateral Cutaneous Branches**) **of the Anterior Branches of the Second and Third Thoracic Nerves.** —As a rule, the first thoracic nerve does not give off a lateral branch. That which springs from the second thoracic nerve is the largest of the series, and differs from the others in not dividing into an anterior and a posterior branch. It is termed the *intercosto-brachial nerve*, on account of its being distributed to the skin on the medial and dorsal aspects of the proximal part of the arm. To reach this destination it crosses the axilla and pierces the deep fascia. But before piercing the fascia it establishes communications and forms a plexiform arrangement in the axilla with the medial cutaneous nerve of the arm, and the lateral branch of the third thoracic nerve. The plexus so formed may be joined by another twig which

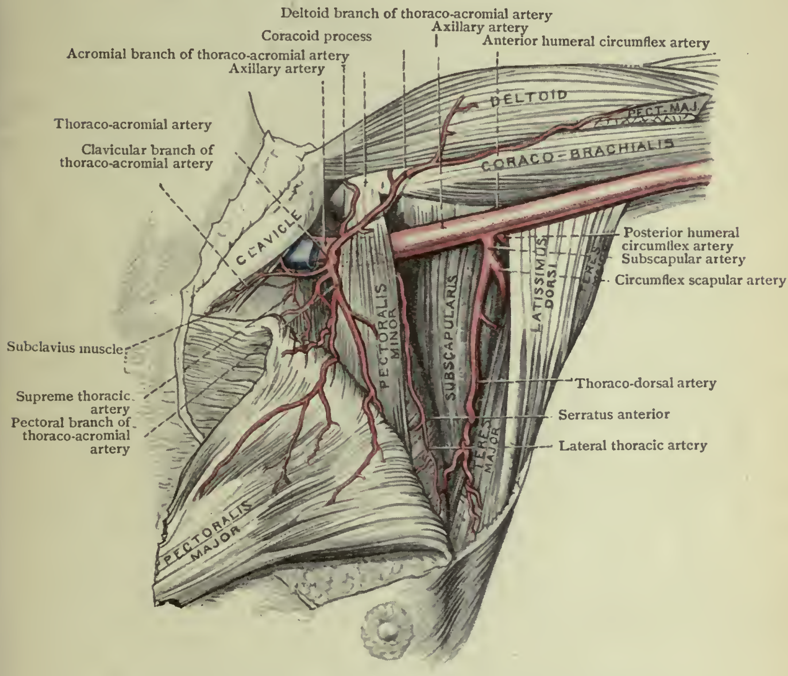


FIG. 15.—Dissection of the Axillary Artery and its Branches.

is occasionally present, viz., the minute lateral cutaneous branch of the first thoracic nerve.

The *lateral branch* of the third thoracic nerve divides into an anterior and posterior part, which are distributed in the ordinary way. From the posterior branch twigs are given to the skin of the axilla, and the terminal twigs are distributed to the integument on the proximal part of the medial aspect of the arm.

Arteria Axillaris.—The axillary artery is the chief artery of the upper limb. It enters the axilla at its apex, at the outer border of the first rib, commencing as the continuation of the subclavian artery. It lies, for a short distance,

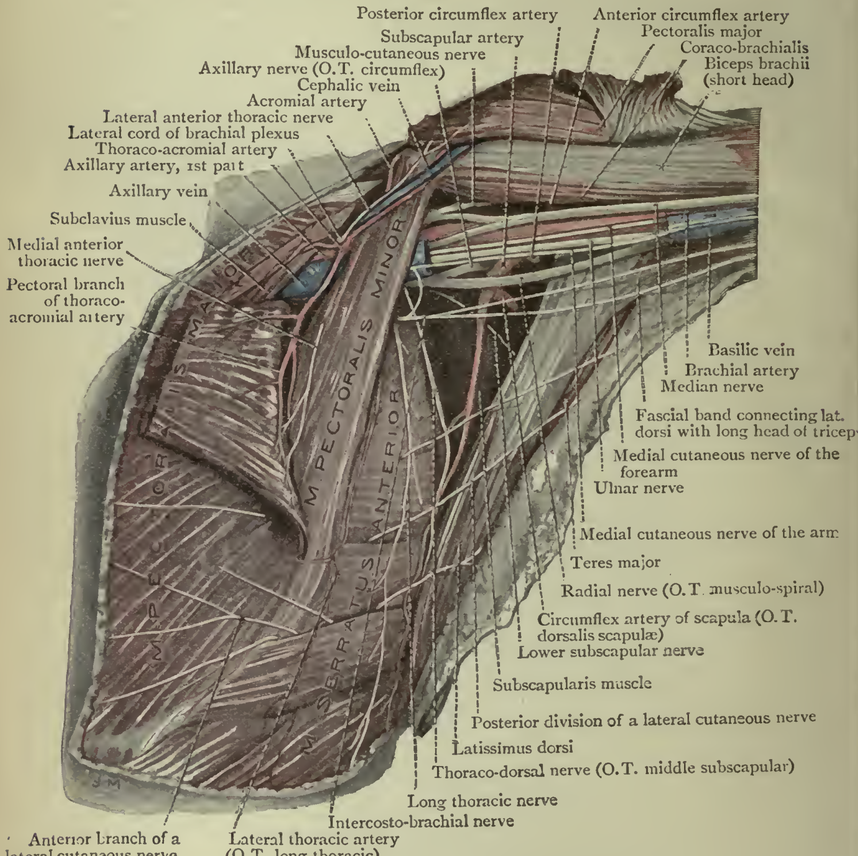


FIG. 16.—The contents of the Axillary Space exposed by the reflection of the Pectoralis Major and the subjacent fascia, and the removal of the fat an the lymph glands. Part of the axillary vein has been removed to expose the medial cutaneous nerve of the forearm and the ulnar nerve.

on the medial wall of the axilla, crosses the fat in the angle between the medial and posterior walls, and then runs along the lateral wall to the lower border of the teres major; there it leaves the axilla and passes into the arm, where it becomes the brachial artery. For convenience of description it is usually divided into three parts—the part above, the part behind, and the part below the pectoralis minor, which are known respectively as the first, second, and third parts. The direction which the artery takes varies with the position of the limb. When the arm is at a right angle with the body, the direction is that of a straight line from the centre of the clavicle to the middle of the bend of the elbow. When the arm is by the side, the artery describes a curve with the convexity directed laterally; and if the arm is raised above the head the curve formed by the artery is convex in the reverse direction.

The *first part* of the axillary artery lies very deeply. It is covered, anteriorly, by the skin, superficial fascia, deep fascia, the clavicular part of the pectoralis major, the costo-coracoid membrane, and the vessels and nerves superficial to it. Even when those are removed the vessel is not completely exposed, because it is enveloped, along with the axillary vein and great nerves, by a funnel-shaped sheath, which is prolonged upon them from the deep cervical fascia (Fig. 12), and it is crossed by the loop of communication between the two anterior thoracic nerves which lies in front of the sheath. *Behind* this part of the vessel are the first intercostal space and the first digitation of the serratus anterior muscle; the long thoracic nerve and the medial cord of the brachial plexus also cross behind it. To its *medial side*, and somewhat overlapping it, is the axillary vein, whilst *above* and to its *lateral side* are the lateral and posterior cords of the brachial plexus.

The *second part* of the axillary artery is placed behind the two pectoral muscles, and has the three cords of the brachial plexus disposed around it. The medial cord lies upon its medial side, the lateral cord upon its lateral side, and the posterior cord behind it. The axillary vein is still upon its medial side, but is separated from the artery by the medial nerve-cord. Strictly speaking, it is not in apposition with any muscle posteriorly, being separated from the subscapularis muscle by areolo-fatty tissue.

The *third* and *longest part* of the axillary artery is superficial in its distal half, because the anterior wall of the axilla does not extend so far down as the posterior wall. Therefore, whilst the third part of the axillary artery is covered, in its proximal half, by the pectoralis major, its distal half is covered only by the skin and fasciæ. Behind it, proximo-distally, are the subscapularis, the tendon of the latissimus dorsi, and the teres major; but it is separated from the subscapularis muscle by the axillary (O.T. circumflex) and radial (O.T. musculo-spiral) nerves, and from the latissimus dorsi and the teres major by the radial nerve. To its lateral side is the

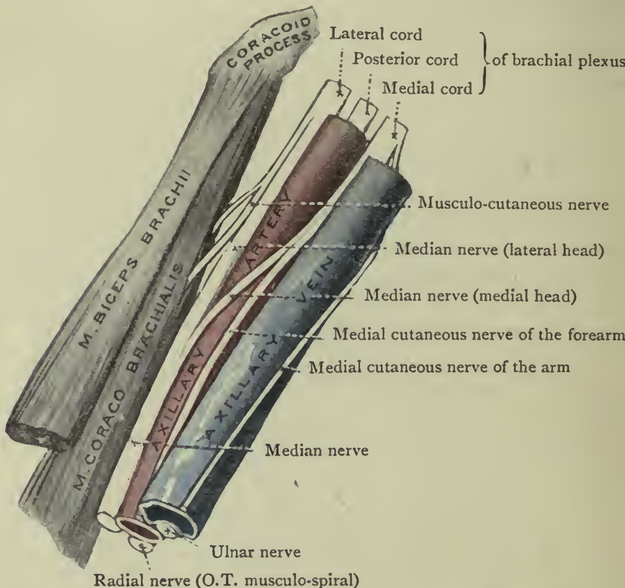


FIG. 17.—Diagram to show relations of Axillary Vessels and Nerves.

coraco-brachialis muscle, but between the muscle and the artery are the musculo-cutaneous and the median nerves. To the medial side of the artery is the vein, with the medial cutaneous nerve of the forearm in the anterior angle between the artery and vein, and the ulnar nerve in the posterior angle between the artery and vein. The medial cutaneous nerve of the arm lies along the medial side of the vein (Fig. 17).

The **branches of the axillary artery** have been seen at different stages of the dissection. They should now be examined more fully (Fig. 15). They are :—

A. thoracalis suprema	from the first part.	A. subscapularis A. circumflexa humeri anterior A. circumflexa humeri posterior	from the third part.
A. thoraco-acromialis A. thoracalis lateralis	from the second part.		

Arteria Thoracalis Suprema (O.T. **Superior Thoracic**).—The supreme thoracic artery is a small branch which springs from the axillary at the lower border of the subclavius. It ramifies upon the upper part of the medial wall of the axilla and supplies twigs to adjacent structures (Fig. 15).

Art. Thoraco-acromialis (O.T. **Acromio-thoracic or Thoracic Axis**).—The thoraco-acromial artery is a short, wide trunk, which takes origin under cover of the pectoralis minor. It winds round the upper border of that muscle, pierces the costo-coracoid membrane, and immediately divides into branches; the branches receive different names, and are arranged as follows:—(*a*) The *clavicular branch*, a small twig, which runs upwards to the clavicle and then turns medially along that bone, between the clavicular part of the pectoralis major and the costo-coracoid membrane. (*b*) The *pectoral branches*, of larger size, run downwards between the two pectoral muscles; they give branches to both muscles, and they anastomose with the lateral thoracic and the lateral branches of the intercostal arteries. (*c*) The *acromial branch* runs laterally, upon the tendon of the pectoralis minor and the coracoid process. Some of its twigs supply the deltoid, whilst others pierce it to reach the superior surface of the acromion. It anastomoses with the transverse scapular (O.T. suprascapular) and posterior humeral circumflex arteries. (*d*) The *deltoid branch*, as a rule, takes origin from a trunk common to it and the preceding artery. It runs distally in the intermuscular interval between the pectoralis major and the deltoid, and supplies both muscles.

Arteria Thoracalis Lateralis.—The lateral thoracic artery takes the lower border of the pectoralis minor as its guide, and proceeds downwards and medially to the side of the thorax. It gives branches to the neighbouring muscles. It anastomoses with twigs from the intercostal arteries, and it also supplies the mamma, giving off, as a rule, an *external mammary branch*, which winds round or pierces the lower border of the pectoralis major on its way to the gland.

Alar Thoracic.—This small artery supplies the fat and lymph glands in the axilla, but it is rarely present as a separate branch, and its place is usually taken by twigs from the subscapular and lateral thoracic arteries.

Arteria Subscapularis.—The subscapular branch of the axillary is a relatively large and comparatively short branch which springs from the parent trunk at the lower border of the subscapularis muscle. It descends, for about one inch, along the lower border of the subscapularis, and then divides into two terminal branches, the a. circumflexa scapulæ, and the a. thoraco-dorsalis. The *circumflex scapular branch* turns round the axillary border of the scapula on its way to the infraspinous fossa of that bone, where it anastomoses with branches of the transverse cervical and transverse scapular arteries. It gives numerous branches to the adjacent muscles. The *thoraco-dorsal branch* descends along the lower border of the subscapularis to the inferior angle of the scapula. It gives branches to the adjacent muscles and anastomoses with the lateral thoracic artery and with branches from the intercostal arteries. It sends branches also into the subscapular fossa which anastomose with twigs of the transverse and circumflex scapular arteries, and with branches of the descending branch of the transverse cervical artery.

Aa. Circumflexæ Humeri, Anterior et Posterior (O.T. **Anterior and Posterior Circumflex Arteries**).—The anterior and the posterior humeral circumflex arteries both arise from the axillary at the same level, a short distance distal to the origin of the subscapular artery. The *posterior humeral circumflex artery* is much the larger of the two. Only a small portion of it can be seen at the present stage. It springs from the posterior aspect of the axillary artery, and at once passes backwards, with the axillary nerve, in the interval between the subscapularis and teres major muscles on the medial side of the surgical neck of the humerus. The smaller *anterior humeral circumflex artery* takes origin from the lateral aspect of the axillary artery, and runs laterally, in front of the surgical neck of the humerus, under cover of the coraco-brachialis and short head of the biceps brachii. Reaching the intertubercular sulcus, it divides into two branches. One of the two is directed proximally, along the long head of the biceps brachii, to the shoulder-joint; the other passes laterally, to the deep surface of the deltoid, and finally anastomoses with some of the terminal twigs of the posterior circumflex artery of the humerus.

Vena Axillaris.—The axillary vein has the same extent as the artery. It begins at the lower border of the teres major, as the proximal continuation of the basilic vein of the arm, and it becomes the subclavian vein at the outer margin of the first rib. At the lower margin of the subscapularis it receives the two *venæ comites* of the brachial artery, and above the level of the pectoralis minor it is joined by the cephalic vein. Its other tributaries correspond, more or less closely, to the branches of the axillary artery.

M. Subclavius.—The subclavius is a small muscle which lies immediately below the clavicle, enclosed between the two layers of the costo-coracoid membrane. It takes origin, by a short rounded tendon, from the superior surface of the first costal arch, at the junction of the bone with the cartilage, and the fleshy belly is inserted into the shallow groove on the inferior surface of the clavicle. The nerve of supply is derived from the fifth and sixth cervical nerves and enters the posterior surface of the muscle. When the muscle contracts it depresses the clavicle and draws it slightly forwards.

Dissection.—When the subclavius has been examined it must be divided horizontally, and when that has been done the costo-clavicular ligament will be found behind the medial end of the muscle.

At this stage, with the assistance of the dissector of the head and neck, the clavicular part of the sterno-cleido-mastoid muscle must be detached from the superior border of the clavicle and the sternal part of the muscle must be pulled towards the median plane.

Articulatio Sternoclavicularis.—The sterno-clavicular joint is a diarthrodial joint, formed by the sternal end of the clavicle, the lateral part of the superior border of the manubrium sterni, and the superior surface of the sternal end of the cartilage of the first rib. It helps to increase the range of the forward, backward, and upward movements of the arm. The clavicle is attached to the sternum and the first rib by a strong fibrous capsule. Within the capsule is an articular disc which separates the joint cavity into two parts. It is attached to the superior border of the sternal end of the clavicle, to the superior surface of the first costal cartilage, and to the anterior and posterior parts of the capsule. On the lateral aspect of the capsule there is a strong accessory ligament, the *costo-clavicular ligament*, which lies behind the origin of the subclavius muscle and passes upwards, backwards, and laterally from the first rib to the costal tubercle on the lower surface of the clavicle. In the capsule itself there are three thickened bands, an anterior, a posterior, and a superior, and as some of the fibres of the latter pass from one clavicle to the other, it is called the *interclavicular ligament*.

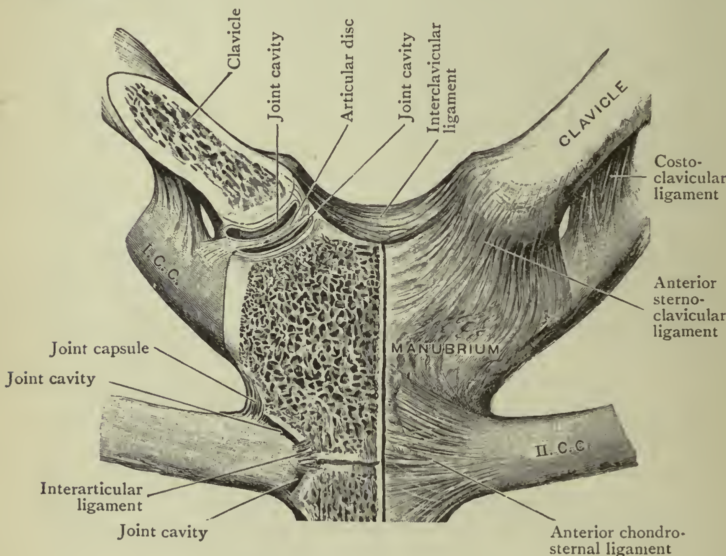


FIG. 18.—Sterno-clavicular and Costo-sternal Joints.

Dissection.—Pull the sternal head of the sterno-cleido-mastoid muscle towards the median plane. Cut through the anterior part of the capsule of the joint close to the sternum. Pass the knife behind the capsule, avoiding the anterior jugular vein, which runs laterally behind the upper border of the joint, and detach the fibres of origin of the sterno-hyoid muscle which spring from the back of the capsule. Cut through the posterior ligament and pull the clavicle laterally. The articular disc is now exposed. Detach it from the first rib; then carry the knife laterally below the clavicle and cut through the lower part of the capsule and the costo-clavicular ligament. The clavicle can now be displaced sufficiently upwards and laterally to bring the whole of the brachial plexus into view. Before studying the plexus, the dissector should note that behind the sterno-clavicular joint there are the lower fibres of the sterno-hyoid and sterno-thyreoid muscles which intervene, on the right side, between the capsule of the joint and the bifurcation of the innominate artery into its right common carotid and subclavian branches, and, on the left side, between the joint and the left common carotid artery.

Plexus Brachialis (Brachial Plexus).—This important

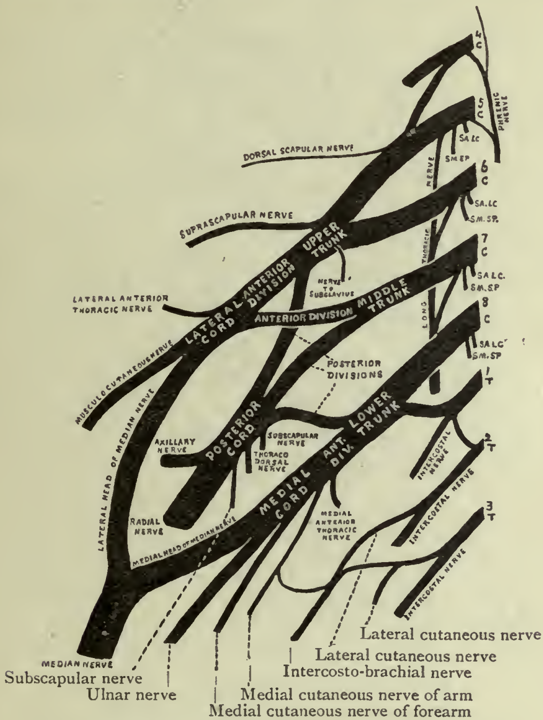


FIG. 19.—Diagram of Brachial Plexus and its Branches.

plexus is formed by the anterior rami of the lower four cervical nerves and the greater part of the anterior ramus of the first thoracic nerve. The plexus is further reinforced, above, by a small twig of communication which passes from the fourth to the fifth cervical nerve, whilst, below, a similar connecting twig not infrequently passes upwards, in front of the neck of the second rib, from the second to the first thoracic nerve. The manner in which the nerves join to form the plexus is very constant. The *fifth* and *sixth cervical nerves* unite to form an *upper trunk*; the *seventh* remains single and proceeds distally as a *middle trunk*; whilst the

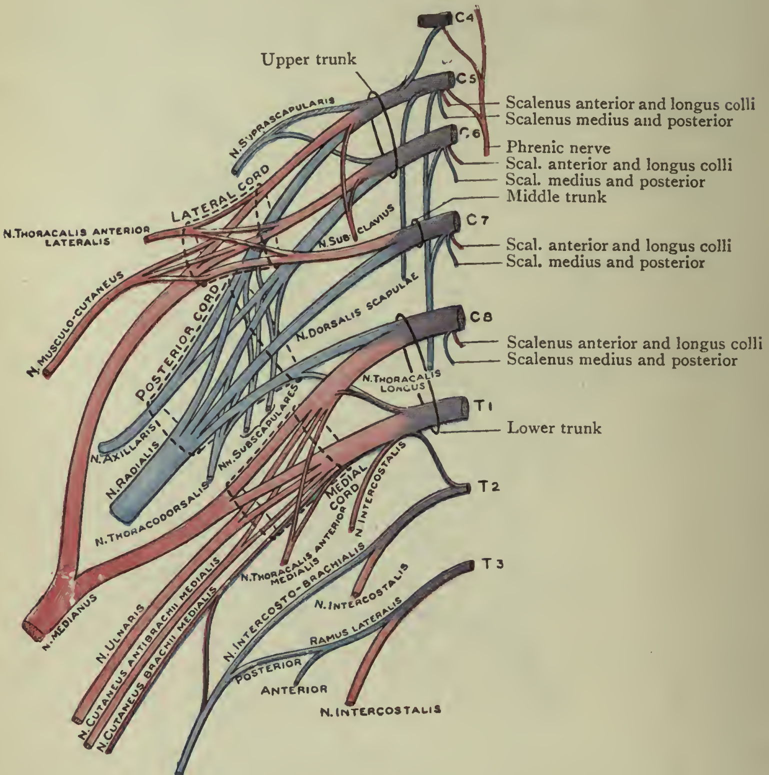


FIG. 20.—Diagram of the Brachial Plexus. (After Paterson.)

eighth and *first thoracic nerves* join, to constitute a *third* or *lower trunk*. A short distance above the clavicle each of the three trunks splits into an *anterior* and a *posterior division*. When the three anterior divisions are raised on the handle of a knife, the three posterior divisions will be seen uniting to form the *posterior cord* of the plexus. It should be noted that the lowest or most medial of the posterior divisions is much smaller than the other two. Of the three anterior divisions the *two upper* join to constitute the *lateral cord*, whilst the *lower* passes distally by itself, as the *medial cord* of the plexus. From the three cords of the plexus the branches are given off which supply the superior extremity (Figs. 19, 20, 22).

From the above description it will be seen that the plexus may be divided into four stages:—

First Stage . .	Five separate nerves (viz., lower four cervical and first thoracic).
Second Stage .	Three nerve-trunks (viz., an upper, middle, and lower).
Third Stage .	Three anterior divisions and three posterior divisions.
Fourth Stage .	Three nerve-cords (viz., a lateral, a medial, and a posterior).

The plexus extends from the lateral border of the scalenus anterior to the lower border of the pectoralis minor, and it lies in the lower and medial part of the posterior triangle of the neck, behind the middle third of the clavicle, and in the axilla. As a rule, the first two stages are in the neck, the third stage is behind the clavicle, and the last stage is in the axilla (Figs. 21, 22).

It has been customary to divide the branches of the plexus into supraclavicular and infraclavicular groups, but such a division is neither scientifically accurate nor of practical importance. The branches of the plexus spring either from its roots, or its trunks, or its cords.

The parts of the plexus above the clavicle, and the branches given off in the supraclavicular region, must be found and cleaned by the dissector of the head and neck; the remaining parts of the plexus and its branches should be displayed by the dissector of the upper extremity, but the two dissectors must combine to examine thoroughly the general relations and the branches of the plexus.

The Relations of the Plexus.—*Superficial to* the cervical part of the plexus lie the skin, the superficial fascia, the platysma, the deep fascia, the external jugular vein, the transverse cervical and transverse scapular veins, the posterior belly of the omo-hyoid muscle, and the transverse cervical artery. *Behind it* is the scalenus medius muscle (Fig. 21).

In the interval between the neck and the axilla, the clavicle and the transverse scapular artery and vein are in front of it; and the third part of the subclavian artery is anterior to its lowest trunk. The scalenus medius is still behind it.

In the axilla it has *in front of it* the integument, the fasciæ, the platysma, the pectoralis major, the pectoralis minor, the costo-coracoid membrane, the cephalic vein, and the axillary artery; *behind it* lie the upper serration of the serratus anterior, the fascia-filled interval between the medial and posterior walls of the axilla, and the subscapularis muscle (Fig. 22).

The Branches of the Plexus.—The branches from the roots of the plexus are: (1) Branches to the scalenus anterior, the longus colli, the scalenus medius, and the scalenus posterior (from C. v., vi., vii., viii.). (2) A communication to the phrenic nerve (from C. v., or v. and vi.).

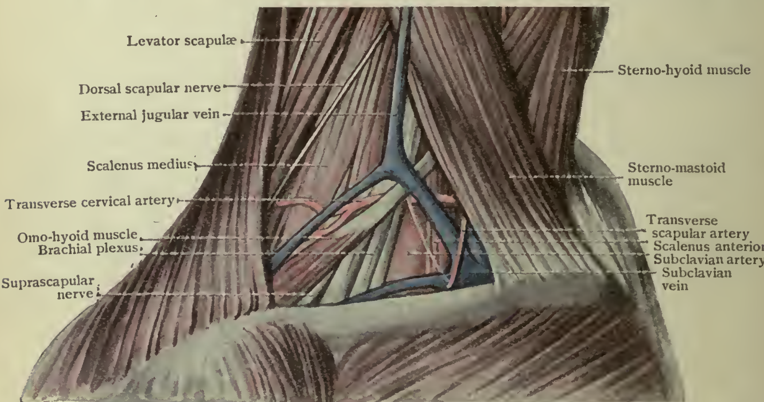


FIG. 21.—Dissection of the lower part of the Posterior Triangle of the Neck, showing the Supraclavicular Part of the Brachial Plexus.

(3) The dorsalis scapulæ nerve, which supplies the rhomboid muscles (from C. v.). (4) The long thoracic nerve, which supplies the serratus anterior (from C. v., vi., vii.).

The branches from the trunks of the plexus are: (1) The nerve to the subclavius, from the upper trunk (from C. v., vi.). It has already been seen piercing the posterior surface of the costo-coracoid membrane and entering the posterior aspect of the subclavius (p. 37). (2) The suprascapular nerve, from the upper trunk (from C. v., vi.). It will be found crossing the lower part of the posterior triangle, deep to the posterior belly of the omo-hyoid muscle, and disappearing through the scapular notch on its way to the dorsum scapulæ (Fig. 22).

The branches from the cords are—

From the lateral cord :

Nervus thoracalis anterior lateralis (O.T. **External Anterior Thoracic**) (from C. v., vi., vii.).
N. musculocutaneus (from C. v., vi., vii.).
N. medianus, caput lateralis (O.T. **Outer Head of Median**) (from C. v., vi., vii.).

From the medial cord :

N. thoracalis anterior medialis (O.T. **Internal Anterior Thoracic**) (from C. viii., T. i.).
N. cutaneus antibrachii medialis (O.T. **Internal Cutaneous**) (from C. viii., T. i.).
N. cutaneus brachii medialis (O.T. **Lesser Internal Cutaneous**) (from T. i.).
N. medianus, caput medialis (O.T. **Inner Head of Median**) (from C. viii., T. i.).
N. ulnaris (from C. viii., T. i.).

From the posterior cord :

Nn. subscapulares (O.T. **Upper and Lower**) (from C. v., vi.).
N. thoracodorsalis (O.T. **Long Subscapular**) (from C. vi., vii., viii.).
N. axillaris (O.T. **Circumflex**) (from C. v., vi.).
N. radialis (O.T. **Musculospiral**) (from C. v., vi., vii., viii., T. i).

In the above table the different spinal nerves from which the fibres of the several branches are derived are indicated.

Nn. Thoracales Anteriores.—The anterior thoràcic nerves supply the pectoral muscles. They are two in number, the lateral and the medial. The *lateral anterior thoracic nerve* springs from the lateral cord of the plexus, passes forwards across the lateral side of the first part of the axillary artery, communicates, in front of the artery, with the medial nerve, pierces the costo-coracoid membrane, and breaks up into branches which end in the pectoralis major. The *medial anterior thoracic nerve* is smaller than the lateral. It springs from the medial cord of the plexus, passes forwards between the axillary artery and vein, communicates, in front of the artery, with the lateral nerve, gives twigs of supply to the pectoralis minor, then pierces that muscle and ends in the pectoralis major, which it supplies. The pectoralis major is, therefore, supplied by both anterior thoracic nerves, the pectoralis minor by the medial nerve alone.

Nn. Subscapulares.—The subscapular nerves are two in number—the *upper* and the *lower*. They spring from the posterior cord of the plexus. After a very short course the upper nerve sinks into and supplies the upper and posterior part of the subscapularis. The lower subscapular nerve passes downwards and laterally, gives branches to the lower part of the subscapularis, then passes through the angle

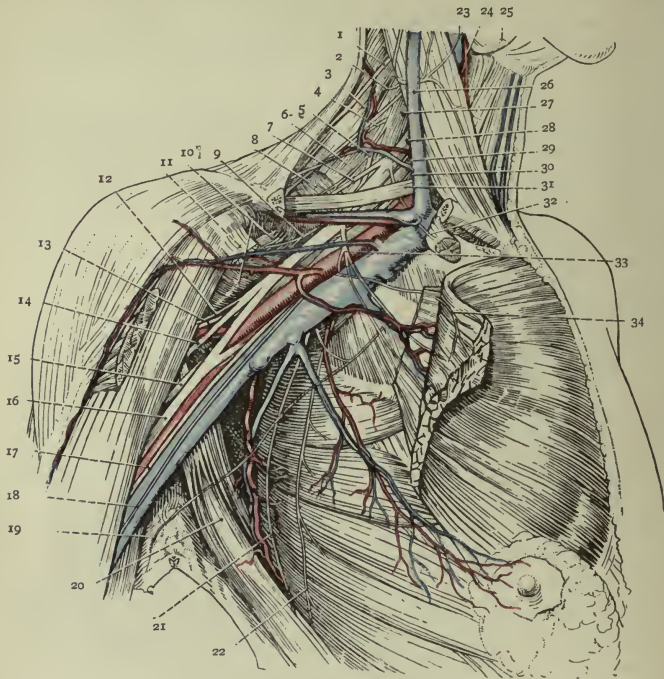


FIG. 16.—Dissection to show the General Relations of the Brachial Plexus.

1. Accessory nerve.
2. Nerve to levator scapulæ.
3. Levator scapulæ.
4. Dorsal scapular nerve.
5. Long thoracic nerve.
6. Scalenus medius.
7. Suprascapular nerve.
8. Serratus anterior.
9. Upper subscapular nerve.
10. Subscapularis.
11. Pectoralis minor.
12. Nerve to coraco-brachialis.
13. Axillary nerve.
14. Musculo-cutaneous nerve.
15. Radial nerve.
16. Median nerve.
17. Medial cutaneous nerve of forearm.
18. Medial cutaneous nerve of arm.
19. Intercosto-brachial nerve.
20. Latissimus dorsi.
21. Thoraco-dorsal nerve.
22. Long thoracic nerve.
23. Internal jugular vein.
24. Superior thyreoid artery.
25. Submaxillary gland.
26. External jugular vein.
27. Scalenus medius.
28. Upper trunk of brachial plexus.
29. Middle trunk of brachial plexus.
30. Eighth cervical nerve.
31. Omo-hyoid.
32. Nerve to subclavius.
33. Lateral anterior thoracic nerve.
34. Medial anterior thoracic nerve.

between the thoraco-dorsal and circumflex scapulæ arteries and ends in the teres major, which it supplies.

N. Thoracodorsalis (O.T. **Long Subscapular Nerve**).—The thoraco-dorsal nerve springs from the posterior cord of the plexus, passes obliquely downwards and laterally, through the axilla, and joins the thoraco-dorsal artery near the lower part of the lateral border of the subscapularis muscle. After cross-

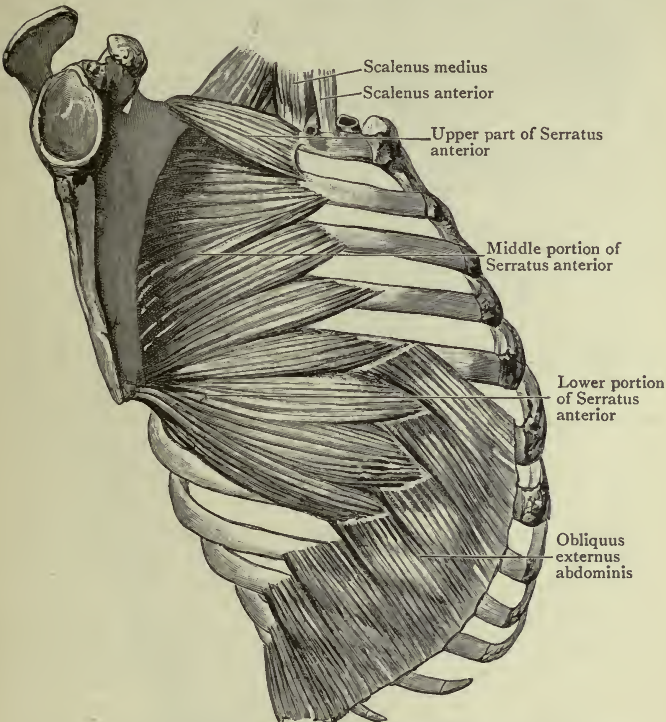


FIG. 23.—Serratus Anterior muscle and origin of the External Oblique muscle ; the scapula is drawn away from the side of the chest.

ing in front of the artery it terminates in the latissimus dorsi, which it supplies.

N. Thoracalis Longus (O.T. **Posterior Thoracic or External Respiratory Nerve of Bell**).—The long thoracic nerve may now be studied in its whole length. It passes downwards on the lateral surface of the serratus anterior, and is the nerve of supply to that muscle. It arises, in the root of the neck, from the brachial plexus, by three roots. The upper two roots (one from the fifth cervical and the other from the sixth cervical nerve) pierce the scalenus medius, and, uniting

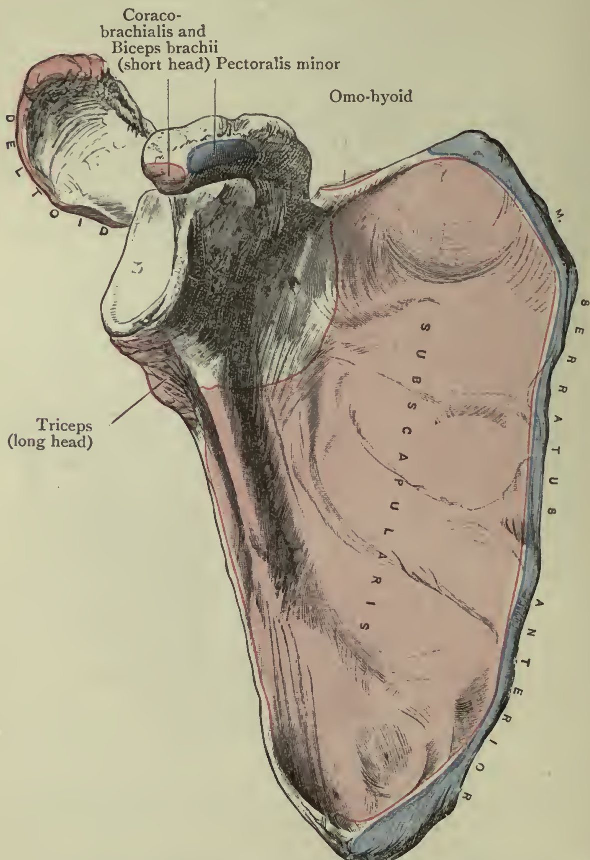


FIG. 24.—Costal aspect of the Scapula with the Attachments of Muscles mapped out.

into one stem, give off branches to the upper part of the serratus anterior. The third root takes origin from the seventh cervical nerve, passes in front of the scalenus medius, and runs downwards for a considerable distance on the surface of the serratus anterior, before it unites with the other part of the nerve. The entire nerve can be followed to the lower part of the serratus anterior, giving twigs to each of its digitations.

M. Serratus Anterior (O.T. Serratus Magnus).—The serratus anterior arises by fleshy digitations from the upper eight ribs, about midway between their angles and cartilages. The slips are arranged on the chest wall so as to present a gentle curve convex forwards. The lower three interdigitate with the external oblique muscle of the abdomen. The serratus anterior is inserted into the entire length of the anterior lip of the vertebral margin of the scapula, and it falls naturally into three parts. (*a*) The *upper part*, composed of the large first digitation alone, arises from the first and second ribs, and from a tendinous arch between them. The fibres converge, to be inserted into a somewhat triangular surface on the costal aspect of the medial angle of the scapula. (*b*) The *middle part* consists of two digitations which take origin from the second and third ribs. The upper slip is very broad, and springs from the lower border of the second rib. The fibres of the middle part diverge to form a thin muscular sheet, which is inserted into the anterior lip of the vertebral margin of the scapula, between the insertions of the upper and lower portions. (*c*) The *lower part* is formed by the remaining digitations of the muscle. They converge to form a thick mass, which is inserted into a rough surface upon the costal aspect of the inferior angle of the scapula. The deep surface of the serratus anterior is in contact with the chest wall. It is the most powerful protractor of the whole upper extremity.

DISSECTION OF THE BACK.

Dissection.—At the end of the fifth day, after the dissector has examined the serratus anterior and carefully revised the contents of the axilla, he must replace the clavicle, pack the axilla with tow or rags steeped with preservative solution and fix the skin flaps to the wall of the thorax with a few stitches. When he returns on the sixth day he will find that the body has been placed upon its face, with blocks supporting the chest and the pelvis. It will remain in that position for five days, and during the first two of those the dissector of the upper extremity must examine the structures which connect the limb with the posterior aspect of the trunk.

Surface Anatomy.—In the median line of the back there

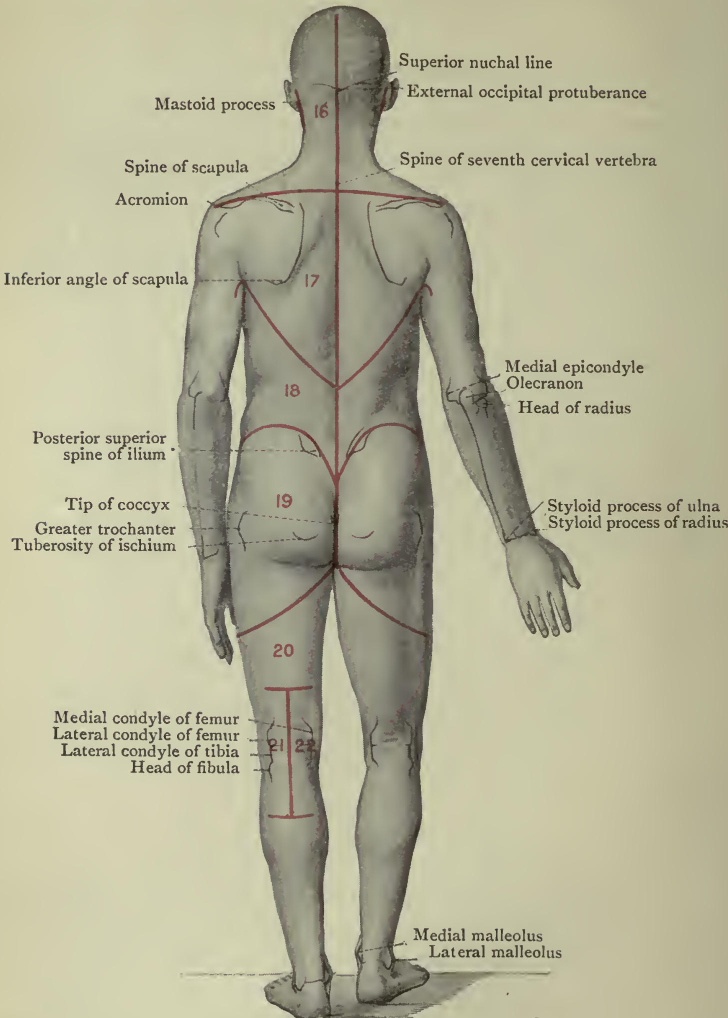


FIG. 25.—Surface View showing Incisions and Bony Points.

is little difficulty in recognising the tips of the spinous processes of the vertebræ (Fig. 25). They follow each other in consecutive order, and it may be noted, when the finger is passed over them, that all of them do not lie in the median plane; some may be deflected, in a slight degree, to one side or the other. The spines of the vertebræ are the only parts of the spinal column which come to the surface; they alone yield direct information, by touch, to the surgeon as to the condition of the spine. At the lower end of the neck, the spine of the seventh cervical vertebra (*vertebra prominens*) makes a visible projection; and the spines of the first two thoracic vertebræ likewise are very prominent. As a rule, the most evident of the three is that of the first thoracic vertebra. At a lower level, in subjects of good muscular development, a median furrow is produced by the prominence of the sacrospinalis muscle on each side, and the spines of the vertebræ may be felt at the bottom of the groove. The furrow attains its greatest depth in the upper part of the lumbar region, and it fades away, below, at the level of the spine of the third sacral vertebra. The finger should next be passed downwards from the third sacral spine, between the buttocks, along the lower part of the tuberculated posterior surface of the sacrum, and along the posterior surface of the coccyx to the tip of the coccyx, which is the inferior extremity of the vertebral column. Afterwards the finger should be carried along the crest of the ilium. It commences at the posterior superior spine of the ilium which can easily be detected because its position is indicated by a small but distinct dimple which lies at the level of the second sacral spine. From the posterior superior spine the crest of the ilium pursues a sigmoid course, laterally and forwards. The highest point it reaches is on a level with the spine of the fourth lumbar vertebra, and it terminates in front in a prominence called the anterior superior spine.

The scapula, or shoulder blade, is, for the most part, thickly covered by muscles; but, in spite of that, its general outline can be made out (Fig. 25). It covers a considerable area of the upper portion of the posterior aspect of the thorax. With the hand by the side its medial angle lies over the second rib, the root of its spine is placed opposite the spine of the third thoracic vertebra, whilst its inferior angle reaches down as far as the seventh, or even the eighth, rib. The scapula is very mobile, and moves to a greater or less degree with every movement of the limb. The spine and acromion of the scapula are subcutaneous throughout. Below the scapula the lower five ribs can be distinguished, and the tip of the last rib can be felt at a point about two inches or less above the iliac crest.

As the back is dissected the following are the parts which must be examined:—

1. The cutaneous vessels and nerves of the back. 2. The trapezius muscle. 3. The latissimus dorsi muscle.	1st day.
4. The rhomboid muscles and their nerve. 5. The levator scapulæ muscle. 6. The accessory nerve and the nerves from the cervical plexus which supply the trapezius. 7. The transverse cervical artery and its two terminal branches. 8. The posterior belly of the omo-hyoid muscle. 9. The transverse scapular artery and the suprascapular nerve.	2nd day.

This dissection must be completed *in two days*, in order that the dissector of the head and neck may be enabled to continue the deeper dissection of the back. The *first day's work* should comprise—(1) the reflection of the skin; (2) the dissection of the cutaneous nerves and vessels; and (3) the cleaning of the latissimus dorsi and trapezius muscles. The remainder of the dissection can be undertaken on *the second day*.

Dissection.—Reflection of the Skin.—The following incisions are necessary:—1. From the tip of the coccyx, at the lower end of the vertebral column, upwards, along the median line of the body, to the spine of the seventh cervical vertebra. 2. From the upper end of 1 transversely, to the tip of the acromion of the scapula. 3. From the lower extremity of the median incision in a curved direction laterally and forwards, along the crest of the ilium, to within two inches of the anterior superior iliac spine. 4. An oblique incision from the spine of the first lumbar vertebra, upwards and laterally, to the posterior fold of the axilla, and along the latter to the arm. The two large flaps (17 and 18, Fig. 25) which are now mapped out upon the back must be carefully raised from the subjacent fatty tissue. Reflect the upper triangular flap first, and then the lower flap.

Panniculus Adiposus (Superficial Fascia).—In subjects which have been allowed to lie for some time on the back the superficial fascia is usually more or less infiltrated with fluid which has gravitated into its meshes; otherwise it has the ordinary characters of superficial fascia (p. 11).

Dissection.—**When searching for the cutaneous nerves cut boldly down through the superficial fascia, in the direction in which the nerves run (Fig. 26), until the plane is reached at which the superficial and deep fascia blend. It is there that the main trunks are to be found, and in a well-injected subject the cutaneous arteries will serve as guides. A more rapid way of finding the cutaneous nerves in this region is to reflect the superficial and deep fascia laterally, from the vertebral spines, in one layer ; the nerves are then found as they issue from the muscles. This plan, however, should be adopted only by the senior student.**

Nervi Cutanei et Vasa Cutanea (Cutaneous Nerves and Vessels).—The *cutaneous nerves* of the back are derived from the posterior rami of the spinal nerves. As the posterior rami pass backwards, they subdivide into medial and lateral divisions. Both divisions supply twigs to the muscles amongst which they lie; but one or the other also contains some sensory fibres which come to the surface, in the shape of a cutaneous nerve, to supply the skin.

In the *thoracic region* the *upper six* or *seven* cutaneous nerves are the terminations of the medial divisions of the posterior rami of the thoracic nerves. They become superficial close to the vertebral spines, and are to be sought for near the median plane. It is not uncommon to find one or more of them piercing the trapezius, one or two inches lateral to the line of emergence of the others. The branch which comes from the second thoracic nerve is the largest of the series; and it may be traced laterally, across the spine of the scapula, towards the shoulder. The *lower five* or *six* cutaneous nerves in the *thoracic region* are the terminal twigs of the lateral divisions of the posterior rami of the thoracic nerves; and, consequently, they must be looked for at a short distance from the middle line of the back. The upper nerves of this group reach the surface after piercing the latissimus dorsi muscle on the line of the angles of the ribs. The lower nerves of the group pierce the lumbo-dorsal fascia at the lateral margin of the sacrospinalis muscle. In every case the cutaneous branches derived from the thoracic nerves turn laterally, in the superficial fascia, and may be traced for a varying distance in that direction.

It is important to note that the area of skin supplied by each of these cutaneous nerves is placed at a lower level than the origin of the posterior ramus from which it arises.

In the *lumbar region* three cutaneous nerves reach the surface after piercing the lumbo-dorsal fascia at the lateral margin of the sacrospinalis muscle, a short distance above the ilium. They are the terminal twigs of the lateral divisions of the posterior rami of the upper three lumbar spinal nerves;

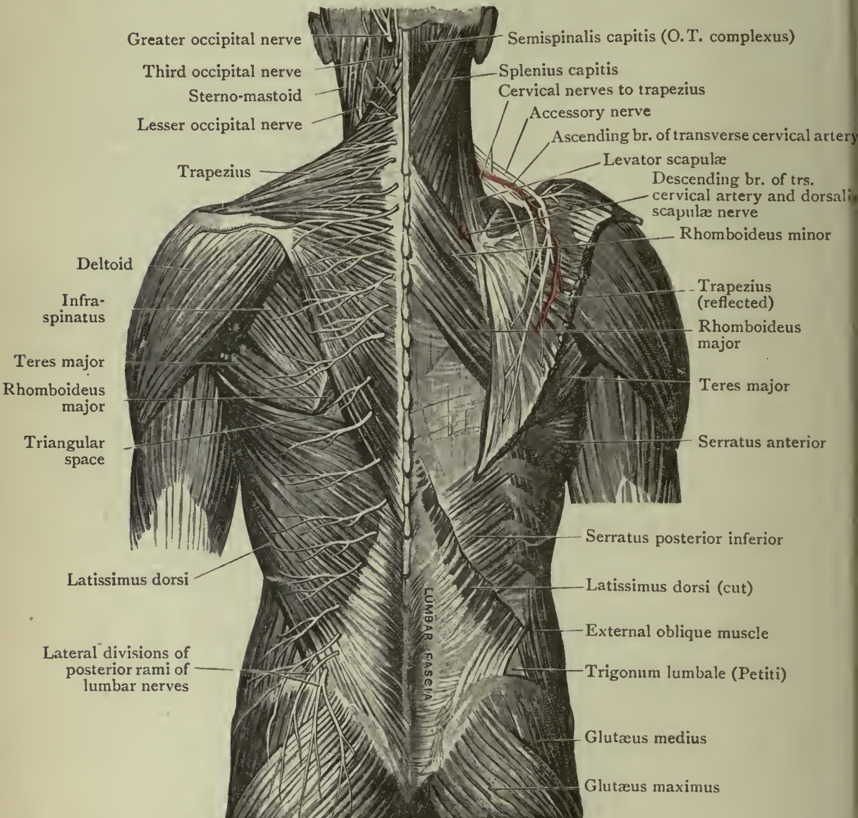


FIG. 26.—Dissection of the Superficial Muscles and Nerves of the Back.

and they differ from the nerves above, inasmuch as they turn downwards over the crest of the ilium to supply the skin of the gluteal region (Fig. 26).

The *cutaneous arteries* which accompany the cutaneous nerves of the back are derived from the posterior branches of the intercostal and lumbar arteries.

Muscles connecting the Limb to the Dorsal Aspect of the Trunk.—This group consists of five muscles, and they are arranged in two strata. Two form the *superficial stratum*, viz., the trapezius and the latissimus dorsi. Both are broad, flat muscles which cover the greater part of the dorsal aspect of the trunk, from the occiput above to the ilium below. The trapezius lies over the back of the neck and the thorax. The latissimus dorsi is placed lower down. The *deeper stratum* of muscles, composed of the levator scapulæ and the two rhomboid muscles, is under cover of the trapezius.

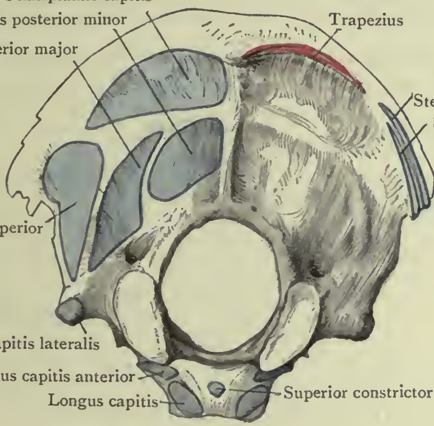


FIG. 27.—Muscle-Attachments to the Occipital Bone.

Dissection.—After the cutaneous nerves and vessels have been displayed and followed to their terminations, clean away the remains of the fatty superficial fascia in the area of the trapezius, but do not injure the deep fascia or the cutaneous nerves; then proceed to clean the trapezius, which is the most superficial muscle of the back. The trapezius belongs only in part to the dissector of the upper extremity. The portion of it which lies above the prominent spine of the seventh cervical vertebra is the property of the dissector of the head and neck, and must be dissected by him. The two dissectors should work in conjunction with each other; and when the entire muscle is exposed, each should give the other an opportunity of studying it in its entirety.

If the dissection is being made on the right side, place the arm close to the trunk and drag the scapula forwards over the end of the block which supports the thorax. Cut through the deep fascia from the seventh cervical spine to the acromion; the incision will correspond with the direction of the fibres of the muscle at the level selected. Work gradually downwards, raising the fascia in a continuous layer from the surface of the muscle. Always carry the scalpel in the direction of the muscle fibres, and take care to leave none of the fascia on the surface of the muscle. As the direction of the muscle fibres changes, alter the position of the arm to keep the fibres which are being cleaned on the stretch. In the case of the *left trapezius*, the preliminary incision through the fascia must be made along the lower margin of the muscle, and the surface of the muscle must be cleaned, from below upwards, to the level of the seventh cervical vertebra. As the deep fascia is removed from the trapezius, and indeed throughout the whole dissection of the back, the cutaneous nerves must be carefully preserved, in order that the dissector of the head and neck may have an opportunity of establishing their continuity with the trunks from which they arise.

M. Trapezius.—The trapezius is a flat, triangular muscle, which lies, in its entire extent, immediately subjacent to the

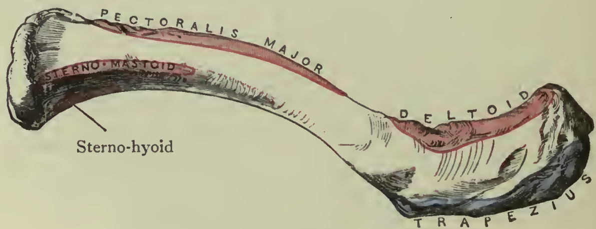


FIG. 28.—Upper Surface of the Right Clavicle.

deep fascia. It has a very long origin, which extends along the median plane, from the occiput above to the level of the last thoracic vertebra below. It arises from—(1) the medial third or less of the superior nuchal line of the occipital bone and the external occipital protuberance; (2) the ligamentum nuchæ and the spine of the seventh cervical vertebra; (3) the tips of the spines of all the thoracic vertebræ, as well as the supraspinous ligaments which bridge across the intervals between them (Figs. 26, 27).

In the lower cervical and upper thoracic regions the tendinous fibres by which the muscle arises lengthen out so as to form a flat tendon, which, taken in conjunction with the corresponding aponeurosis of the opposite side, exhibits an oval outline.

As the fibres of the trapezius pass laterally they converge to their insertions into the two bones of the shoulder-girdle. The *occipital* and *upper cervical fibres* incline downwards, and, turning forwards over the shoulder, are inserted into the posterior border of the lateral third of the clavicle (Fig. 28); the *lower cervical* and *upper thoracic fibres* pass more or less transversely to gain an insertion into the medial border of the acromion and the upper margin of the posterior border of the spine of the scapula; while the *lower thoracic fibres* are directed upwards and, at the vertebral border of the scapula, end in a flat, triangular tendon, which plays over the smooth surface at the apex of the scapular spine, and is inserted into a rough tubercle on the spine immediately beyond that surface (Fig. 38, p. 83). To facilitate the movement of the tendon upon the bone a small bursa mucosa is interposed between them.

The trapezius is supplied by the *accessory nerve* and by twigs from the *third* and *fourth cervical nerves.* It is an elevator and depressor of the shoulder; and a rotator and adductor of the scapula.

Dissection.—The latissimus dorsi is now to be dissected. It is a difficult muscle to clean, not only on account of the varying direction of its fibres, but also because its upper part is generally very thin, and its upper border ill-defined. Near the spines of the vertebræ its upper portion is overlapped by the trapezius, but in its greater part the muscle is subcutaneous. Both the superficial and the deep fascia should be raised at the same time from its surface, and its fibres may be stretched by raising the arm and folding it under the neck.

On the *right side* cut through the fascia along the upper border of the muscle from the point where that margin disappears under the trapezius to the posterior fold of the axilla, and work downwards. Define carefully the attachment to the superficial layer of the lumbo-dorsal fascia. Clean that fascia, but do not injure it; it is the property of the dissector of the head and neck. Next define the attachment of the lower end of the muscle to the crest of the ilium; and when the lower part of the lateral border of the muscle is reached, clean the slips of the latissimus which are attached to the lowest three or four ribs, and clean also the slips of the external oblique muscle of the abdomen which interdigitate with the costal slips of the latissimus dorsi.

On the *left side* cut through the fascia from the crest of the ilium to the posterior fold of the axilla, and work medially and upwards; and when the main part of the muscle has been cleaned, return to the lower part of the lateral border and display the costal attachments of the muscle and the interdigitations of the external oblique.

After the costal slips of the muscle have been defined, evert the upper margin of the muscle, as it crosses the inferior angle of the scapula, to display the slip of fibres which springs from that angle and joins the deep aspect of the upper border of the muscle; it is apt to be mistaken for a piece of the teres major upon which it lies.

M. Latissimus Dorsi.—The latissimus dorsi is a wide, flat muscle, which covers the back from the level of the sixth thoracic vertebra down to the crest of the ilium (Fig. 26, p. 52). It arises—(1) from the tips of the spinous processes of the lower six thoracic vertebræ and the supraspinous ligaments in connection with them; (2) from the superficial lamella of the lumbo-dorsal fascia (Fig. 26); (3) by a thin tendinous origin from a small extent of the outer lip of the crest of the ilium, in

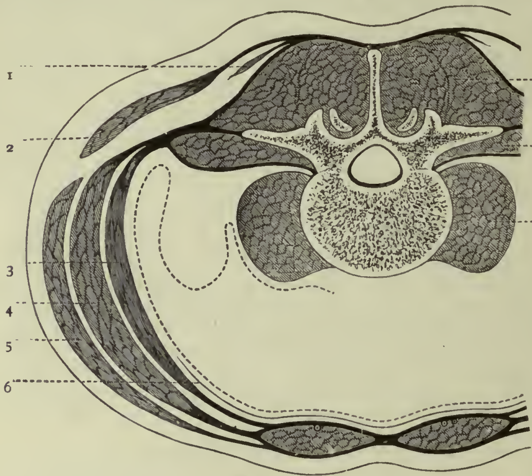


FIG. 29.—Diagram of the Lumbo-dorsal Fascia.

1. Serratus posterior inferior.
2. Latissimus dorsi.
3. Transversus abdominis.
4. Obliquus internus.
5. Obliquus externus.
6. Fascia transversalis.
7. Sacrospinalis.
8. Quadratus lumborum.
9. Psoas major.

front of the lumbo-dorsal fascia (Fig. 26, p. 52); (4) by three or four digitations from the lower three or four ribs; and (5) by a fleshy slip from the dorsal aspect of the inferior angle of the scapula (Fig. 38, p. 83). By means of its origin from the posterior lamella of lumbo-dorsal fascia, it attains an indirect attachment to the spines of the lumbar and upper sacral vertebræ, and also to the posterior part of the crest of the ilium. The costal slips of origin interdigitate with the lower digitations of the external oblique muscle of the abdominal wall.

The fibres of the latissimus dorsi converge rapidly as they approach the lower part of the scapula. The highest fibres pass almost horizontally towards that point; the lowest fibres ascend almost vertically; whilst the intermediate fibres show varying degrees of obliquity. As a result of the convergence of fibres, the muscle is greatly reduced in width; and it sweeps over the inferior angle of the scapula in the form of a thick, fleshy band, which winds round the lower margin of the teres major muscle and terminates in a narrow, flat tendon, which is inserted into the floor of the intertubercular sulcus of the humerus (Fig. 45, p. 107). The insertion cannot be studied at present, but will be seen later. With the teres major muscle, the latissimus dorsi forms the posterior fold of the axilla. At first it is placed on the dorsal aspect of the teres major, then it is folded round its lower border, and finally it is inserted in front of it. To the peculiar relationship of the two muscles is due the full, rounded appearance of the posterior axillary fold.

The latissimus dorsi is supplied by the *thoraco-dorsal nerve.* It is an adductor, retractor, and medial rotator of the upper extremity.

Two Intermuscular Spaces.—(1) A triangular space mapped out by the inferior border of the trapezius, the superior border of the latissimus dorsi, and the base of the scapula, should now be noticed (Fig. 26, p. 52). Within the limits of that triangle a small portion of the rhomboideus major can be seen, and also a varying amount of the wall of the thorax—a part of the sixth intercostal space and the borders of the ribs which bound it above and below. It is well to note that this is the only part of the thoracic wall on the posterior aspect of the trunk which is not covered by muscles. (2) Between the last rib and the crest of the ilium the anterior border of the latissimus dorsi generally overlaps the posterior border of the external oblique muscle of the abdominal wall. Sometimes, however, a narrow triangular interval exists between the two muscles, in which is seen a small part of the internal oblique muscle. That space is termed the *trigonum lumbale* (*Petiti*) (Fig. 26, p. 52). It is a weak part of the wall of the abdomen, and occasionally some of the contents of the abdomen are protruded through it, forming a *lumbar hernia*.

Dissection.—Reflection of the Trapezius.—On the *second day* the dissector must begin by reflecting the trapezius, working, it possible, in conjunction with the dissector of the head and neck. Divide the muscle about two inches from the spines of the vertebræ, and throw it laterally, towards its insertion. The trapezius is very thin at its origin, and the greatest care must therefore be taken not to injure the subjacent rhomboid muscles. The small bursa between the tendon of insertion of the lower part of the trapezius and the flattened apex of the spine of the scapula must not be overlooked, and the nerves and vessels on the deep surface of the muscle must be cleaned and preserved. They are the accessory nerve and branches of the third and fourth cervical nerves, the ascending branch of the transverse cervical artery, and branches of the descending branch of the transverse cervical artery. The latter pass into the trapezius from between the muscles of the second layer.

Nerves and Vessels of Supply to the Trapezius.—A dissection of the deep surface of the reflected muscle will reveal the following structures:—

a. The accessory nerve.
b. Two or three nerves from the cervical plexus.
c. The ascending branch of the transverse cervical artery.
d. Twigs of the descending branch of the transverse cervical artery.

These constitute the nervous and vascular supply of the trapezius.

The nerves have already been displayed by the dissector of the head and neck, as they cross the posterior triangle of the neck. The branches from the cervical plexus come from the *third* and *fourth cervical nerves.* On the deep surface of the trapezius they join with branches of the accessory nerve to form the *subtrapezial plexus*, from which twigs proceed into the substance of the muscle. The terminal twig of the *accessory nerve* can be traced nearly to the lower margin of the trapezius.

The *ascending branch of the transverse cervical artery*, which accompanies the accessory nerve, must be followed to the anterior border of the trapezius, where it will be seen to spring from the trunk of the artery at the point where it divides into its ascending and descending branches.

The *twigs from the descending branch of the transverse cervical artery* pierce the muscles of the second layer or pass between them, close to the vertebral border of the scapula.

Dissection.—The posterior belly of the omo-hyoid, the transverse scapular artery, and suprascapular nerve must now be displayed, and the clavicular and scapular insertions of the trapezius must be examined. Divide the trapezius into an upper and a lower part by a transverse cut at the level of the angle between the clavicle and the spine of the scapula, and verify the attachment of the upper part to the posterior border of the lateral third of the clavicle and the attachment of the lower part to the medial border of the acromion and the upper margin of the posterior border of the spine of the scapula. Next clean away the fat in the area exposed and display the posterior belly of the omo-hyoid muscle, the transverse scapular artery, the suprascapular nerve and the fascia over the supraspinatus. The supraspinatus covers the scapula between the spine and the upper border of the bone. The posterior belly of the omo-hyoid is attached to the lateral part of the upper border. The transverse scapular artery crosses the upper border immediately lateral to the omo-hyoid, resting on the superior transverse ligament, which passes from the upper border to the coracoid process, and separates the transverse scapular artery from the suprascapular nerve.

When the structures mentioned have been defined, draw the scapula well over the edge of the block which supports the thorax, and examine the muscles which attach the vertebral border of the scapula to the vertebral column; they are (1) the *levator scapulæ*, (2) the *rhomboideus minor*, (3) the *rhomboideus major*. The levator scapulæ is attached to the scapula from the medial angle of the scapula to the flattened apex of the spine of the scapula, the rhomboideus minor opposite the flattened apex and the rhomboideus major from the flattened apex to the inferior angle.

Cut through the fascia between the levator scapulæ and the rhomboideus minor about one inch medial to the scapula, and find the *dorsalis scapulæ nerve* which supplies the rhomboid muscles and the descending branch of the transverse cervical artery which accompanies it. (Fig. 26, p. 52.) These structures will be traced to their terminations when the levator scapulæ and the rhomboids are reflected.

M. Omo-hyoideus, Arteria Transversa Scapulæ (O.T. Suprascapular Artery) et N. Suprascapularis.—The slender *posterior belly of the omo-hyoid muscle* will be seen to arise from the upper margin of the scapula, immediately medial to the scapular notch. It derives fibres also from the ligament which bridges across this notch. It is supplied by a twig from a nerve loop in the neck called the ansa hypoglossi. The *transverse scapular artery* will be noticed to enter the supraspinous fossa of the scapula by passing over the superior transverse scapular ligament, whilst the *suprascapular nerve* proceeds into the fossa under cover of that ligament (Fig. 38).

Mm. Rhomboidei.—The two rhomboid muscles constitute a thin quadrangular sheet of muscular fibres, which extends from the spinous processes of the vertebræ to the vertebral margin of the scapula.

The *rhomboideus minor* is a narrow, ribbon-like fleshy band which runs parallel to the upper border of the major rhomboid. It springs from the lower part of the ligamentum nuchæ, the spine of the seventh cervical vertebra, and frequently also from the spine of the first thoracic vertebræ. It is inserted into the vertebral margin of the scapula opposite the triangular surface at the flattened apex of its spine (Fig. 38, p. 83). It is entirely covered by the trapezius.

The *rhomboideus major* arises from the upper four or five thoracic spines, and the corresponding parts of the supraspinous ligaments. Its fibres run obliquely downwards and laterally, and end in a tendinous arch, which is attached to the vertebral margin of the scapula, from the inferior angle to the apex of the spine. The main attachment of the fibrous arch is to the inferior angle, but it is bound to the vertebral border from that point to the spine by fairly firm areolar tissue (Fig. 38, p. 83). The greater part of the rhomboideus major is covered by the trapezius; only a small portion near the inferior angle of the scapula lies immediately subjacent to the deep fascia.

M. Levator Scapulæ.—The levator scapulæ is an elongated muscle which arises by four, more or less tendinous, slips from the posterior tubercles of the transverse processes of the upper four cervical vertebræ. It passes downwards and backwards to be inserted into the vertebral margin of the scapula, from the medial angle to the spine. It is supplied by branches from the *third* and *fourth cervical nerves*.

Dissection.—Clean the levator scapulæ, taking care not to injure the nerves which supply it. The muscle belongs partly to the dissector of the head and neck and partly to the dissector of the superior extremity. When both of them have studied its attachment and nerve-supply, the muscle must be divided at the middle of its length. The lower half is then to be turned downwards and laterally to its insertion, and the dorsalis scapulæ nerve and the descending branch of the transverse cervical artery, which lie deep to the muscle, are to be preserved and followed to the upper margin of the rhomboideus minor.

Next cut through the rhomboids, from above downwards, midway between the scapula and the spines of the vertebræ; remember that they are very thin, and take care not to injure the serratus posterior superior, which is immediately subjacent to them. Turn the medial part of each muscle towards the vertebral spine and verify its attachment. Turn the lateral parts towards the scapula and follow the dorsalis scapulæ nerve and the descending branch of the transverse cervical artery to their terminations. The nerve gives branches to the levator scapulæ and to both the rhomboid muscles, and the artery not only supplies the rhomboids but also the adjacent muscles on the scapula.

Nervus Dorsalis Scapulæ (O.T. Nerve to the Rhomboids).—This long slender nerve arises, in the neck, from the fifth cervical nerve, usually in common with the upper root of the long thoracic nerve. It pierces the scalenus medius, and passes downwards, under cover of the levator scapulæ, to the deep surface of the rhomboidei muscles. It ends in those muscles, but it supplies, also, one or two twigs to the levator scapulæ.

The root twigs of origin of the dorsalis scapulæ nerve sometimes pierce the levator scapulæ separately, and then unite in a plexiform manner.

Ramus Descendens of the Art. Transversa Colli (O.T. Posterior Scapular Artery).—The descending branch of the transverse cervical artery takes origin in the lower part of the neck close to the lateral margin of the levator scapulæ. At first it runs medially under cover of the levator scapulæ, but it soon changes its direction and then runs downwards along the vertebral border of the scapula, under cover of the rhomboid muscles (Fig. 26, p. 52). It gives numerous branches to both the costal and dorsal aspects of the scapula, and its terminal twigs may enter the latissimus dorsi. One large branch usually passes backwards, in the interval between the rhomboid muscles or through the greater rhomboid, to reach the trapezius muscle; and another branch, the *supraspinal*, is given to the supraspinatus muscle and the structures superficial to it.

Dissection.—Reflection of the Latissimus Dorsi and the removal of the Superior Extremity.—Divide the latissimus dorsi. Commence the division at the upper border three inches from the vertebral spine, and carry the knife obliquely downwards and laterally to a point just below where the last digitation of the muscle springs from the last rib. Remember that the muscle is thin, and do not injure the parts subjacent to it. Turn the medial portion towards the vertebral spines, taking care not to injure the serratus posterior inferior in the region of the lower four ribs, and verify the origin of the muscle from the spines and supraspinous ligaments, lumbar fascia and iliac crest. Throw the lateral part of the muscle laterally and forwards, clean the deep surfaces of the slips attached to the lower three or four ribs, and note that they interdigitate with the external oblique muscle of the abdomen. At the inferior angle of the scapula find the thoraco-dorsal nerve and the thoraco-dorsal artery. They supply the muscle and enter its deep surface.

The Removal of the Superior Extremity.—(1) Divide the transverse scapular artery and the suprascapular nerve and the posterior belly of the omo-hyoid at the upper border of the scapula.

(2) Divide the dorsal scapular nerve and the descending branch of the transverse cervical artery near the medial angle of the scapula.

(3) Pull the vertebral border of the scapula away from the ribs to expose the posterior part of the serratus anterior on the costal surface of the scapula.

(4) Cut through the posterior part of the serratus anterior from its upper to its lower border about one inch from the vertebral margin of the scapula.

(5) Pull the scapula still further away from the thorax and divide the axillary vessels and nerves at the outer border of the first rib.

(6) Detach the anterior skin flap previously stitched to the anterior wall of the thorax, and take the limb to the table provided, where the further dissection is to be completed.

Tie the divided axillary vessels and nerves to a piece of wood, about 37.5 mm. ($1\frac{1}{2}$ inches) long, in their proper order (a piece of a broken penholder will serve the purpose), and then by means of a loop fix the wood to the coracoid process; by that means the vessels and nerves will be retained in their proper relationships during the further stages of dissection, and they can be released from the coracoid process when it is necessary to examine anything which lies behind them.

After the superior extremity has been separated proceed to remove the whole of the skin which covers it whilst the subcutaneous tissues are still in good condition, and in order that a general view of the cutaneous veins and nerves may be obtained. The main cutaneous veins carry blood to the axillary vein, and the cutaneous nerves are either direct branches of the brachial plexus or they spring from the main terminal branches of the plexus. The following steps must be taken: (1) place the limb on its posterior aspect; (2) make an incision along the anterior aspect from the region already denuded to the tip of the middle finger (Fig. 5); (3) make a transverse incision at the wrist; (4) a transverse incision at the proximal ends of the fingers; (5) an oblique incision from the middle of wrist to the tip of the thumb; (6) incisions along the middle of the index, the ring, and the little finger. Turn the lateral flaps 3 and 5 (Fig. 5) laterally, the medial flaps 4 and 6 medially round the respective margins of the limb, and then dissect them from the dorsal aspect. Treat the flaps 5 and 7 and those of the fingers in the same way, and dissect flap 6 distally to the angle between the thumb and the index finger.

Take great care whilst removing the flaps not to injure the cutaneous vessels and nerves which lie in the superficial fascia immediately subjacent to the skin.

Note that the skin is readily separated from the superficial fascia in the arm and forearm and on the dorsal aspect of the hand. It is slightly more adherent over the epicondyles of the humerus and the olecranon. In the regions of the palm and the volar aspects of the digits, the skin and superficial fascia are closely adherent, for there the skin is bound to the deep fascia by fibrous strands which pass through the superficial fascia. In the ulnar part of the palm, about 25 mm. distal to the wrist, some muscle fibres will be brought into view; they connect the skin on the ulnar margin of the palm with the deep fascia, and constitute the *palmaris brevis muscle.*

When the skin is completely removed it must not be thrown away but must be kept to be wrapped round the part where the dissection is not proceeding.

Cutaneous Veins of the Superior Extremity.—After the skin has been removed proceed to display the cutaneous veins, because they are, except here and there, the most superficial structures, but be careful to preserve any nerves met with as the veins are being cleaned (Figs. 31, 32).

Commence at the interval between the pectoralis major and the deltoid and follow the cephalic vein distally, being careful to preserve the tributaries which join it. At the bend of the elbow secure a large communicating branch called the *median cubital vein*; it runs obliquely, proximally, and medially, and joins the *basilic vein*, about 30 mm. proximal to the level of the medial epicondyle. The median cubital vein is joined at its distal border by a vein which pierces the deep fascia and connects the median cubital vein with the deep veins of the forearm. After the median cubital vein and its connections have been displayed, follow the cephalic vein distally, along the forearm and round its radial margin, to the dorsum of the hand where it commences, dorsal to the first metacarpal bone, in the radial extremity of the *dorsal venous arch.* The dorsal venous arch crosses the dorsum of the hand, from the radial to the ulnar side, and at its ulnar end, which lies opposite the interspace between the fourth and fifth metacarpal bones, the *basilic vein* commences. Follow the basilic vein proximally. It passes at first along the dorsal aspect of the ulnar border of the forearm, then turns round the ulnar border to the front, and ascends to the arm, where it is joined by the median cubital vein already dissected. Follow the basilic vein proximally beyond its junction with the median cubital vein to the middle of the arm where it pierces the deep fascia, at the level of the insertion of the coraco-brachialis muscle. As you clean it, in the lower part of the arm, look for some superficial cubital lymph glands which lie in the superficial fascia; a little proximal to the elbow they receive lymph from the fingers, palm, and the anterior aspect of the forearm, and are apt to become inflamed and painful when wounds of those parts become septic. The cephalic and the basilic veins receive tributaries, which vary in number and size, both from the dorsal and the volar surfaces of the forearm and hand.

When the cephalic and basilic veins and their main tributaries have been cleaned, return to the dorsum of the hand, clean the dorsal venous arch and the tributaries which pass to it from the digits; they are (1) *three dorsal metacarpal veins*, one opposite each of the three medial interdigital clefts; (2) the radial dorsal digital vein from the index finger. On the dorsum of each digit look for two *dorsal digital veins*, one along the radial and one along the ulnar border. The dorsal digital veins of the thumb join the cephalic vein; the ulnar dorsal digital vein of the little finger usually joins the basilic vein; the other dorsal digital veins terminate in the dorsal metacarpal veins. The two dorsal digital veins on each finger are united by many channels which form a series of arcades, the *dorsal digital venous arches.* The

superficial veins on the dorsum of the hand communicate through the interdigital clefts with the deep and superficial veins of the palm.

The superficial veins on the volar aspects of the fingers and in the palm are small, and cannot as a rule be displayed in an ordinary dissection, but, springing from a network in the superficial fascia of the palm, or appearing in the superficial fascia of the volar aspect of the wrist, there is occasionally a *median antebrachial vein* which passes proximally, along the middle of the volar aspect of the forearm, towards the elbow. A short distance distal to the elbow it either joins the median cubital vein or it divides into two branches, the median basilic and the median cephalic, which terminate respectively in the basilic and cephalic veins.

Accompanying the various superficial veins of the superior extremity there are numerous lymph vessels which collect lymph from the regions drained by the veins. Those which accompany the proximal part of the cephalic vein, and which are derived partly from the dorsum of the forearm and partly from the dorsum of the arm and the lateral part of the shoulder, pass to the delto-pectoral and infraclavicular lymph glands; some of the lymph vessels which accompany the basilic vein end in the superficial cubital glands, above the medial epicondyle; the remainder, and the efferents of the superficial cubital glands, accompany the proximal part of the basilic vein, and, after piercing the deep fascia, they terminate either in the brachial glands or the lateral group of axillary glands (Fig. 9).

The superficial lymph glands can often be found by a careful dissector, but the superficial lymph vessels are difficult to demonstrate in an ordinary dissecting-room "part." They appear as fine white strands, and are most easily distinguished as they enter or leave the glands.

Vena Cephalica.—The cephalic vein commences at the radial end of the venous arch on the dorsum of the hand. It receives the two dorsal digital veins from the thumb, and then turns round the radial border of the distal part of the forearm and ascends to the region of the elbow; there the greater part of the blood which it carries is transmitted to the basilic vein by the large median cubital vein. Proximal to the level of the median cubital vein, the cephalic vein ascends either along the lateral part of the biceps, or in the groove at the lateral border of the biceps, to the lower border of the pectoralis major; there it pierces the deep fascia (Fig. 31), and then continues proximally in the groove between the pectoralis major and the deltoid to the delto-pectoral triangle. In the delto-pectoral triangle it crosses the lateral part of the pectoralis minor, and turns medially between the clavicular part of the pectoralis major and the costo-coracoid membrane. In this terminal part of its course it lies anterior to the axillary artery, but is separated from the artery by the costo-coracoid membrane. Finally it pierces the costo-coracoid membrane and joins the axillary vein. It receives (1) the dorsal digital veins of the thumb, (2) tributaries from the volar and dorsal aspects of the forearm, (3) tributaries from the lateral and dorsal aspects of the arm, (4) a tributary from the side of the shoulder, and (5), immediately before it pierces the costo-coracoid membrane, it is joined by the venæ comites of the deltoid and acromial branches of the thoraco-acromial artery. It is accompanied by lymph vessels from the dorsum of the hand, and the lateral and dorsal sides of the forearm and arm; those vessels terminate in the delto-pectoral lymph glands.

Vena Basilica.—The basilic vein commences at the ulnar end of the dorsal venous arch of the hand. It receives the dorsal digital vein from the ulnar side of the little finger and then ascends on the ulnar part of the dorsal surface of the forearm. Below the elbow it turns round the ulnar border of the forearm and ascends to the groove along the medial border of the biceps brachii. About 30 mm. above the medial epicondyle it is joined by the median cubital vein, then it continues proximally to the level of the middle of the arm, where it pierces the deep fascia. After it has pierced the deep fascia, it runs along the medial side of the brachial artery to the lower border of the teres major, where it becomes the axillary vein; only the termination of this part of the vein can be seen at present, the remainder will be displayed in a later dissection. The tributaries of the basilic vein are (1) the ulnar dorsal digital vein of the little finger, (2) tributaries from the volar and dorsal aspects of the forearm, (3) the median cubital vein, (4) tributaries from the medial and posterior parts of the arm. It is accompanied by lymph vessels from the dorsum and palm of the hand and the volar and dorsal aspects of the forearm. Some of the accompanying lymph vessels end in the superficial cubital glands, which lie proximal to the medial epicondyle. Others pass directly to the brachial and the lateral axillary glands.

Vena Mediana Cubiti.—The median cubital vein is a large communicating vein which springs from the cephalic vein about 25 mm. below the bend of the elbow, and terminates in the basilic vein 30 mm. above the medial epicondyle. As it crosses from the cephalic to the basilic vein it receives tributaries from the volar aspect of the forearm, it is separated from the distal part of the brachial artery by a thickened portion of deep fascia called the *lacertus fibrosus*,[1] and it is crossed either deeply or superficially by the volar branch of the medial cutaneous nerve of the forearm (Fig. 31).

The Lymph Vessels and Lymph Glands of the Superior Extremity.—With the exception of a few lymph vessels which the dissector may have

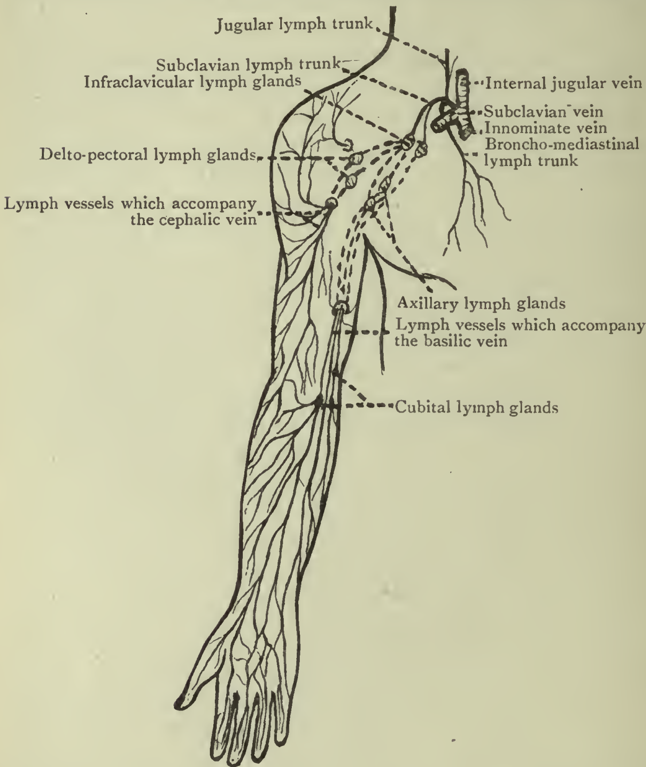


FIG. 30.—Diagram of the Superficial Lymph Vessels and Lymph Glands of the Right Superior Extremity.

found passing to and from the axillary lymph glands (p. 29), the lymph vessels of the superior extremity cannot be displayed in an ordinary dissecting-room "part," and it is only occasionally in the hospital, the post-mortem room, and in specially prepared subjects that an opportunity for seeing the lymph vessels will occur. It is unfortunate that this should

[1] The strengthening fibres of the lacertus fibrosus are derived from the tendon of insertion of the biceps brachii.

be the case, because the lymph vessels and lymph glands are of great clinical importance, and their positions and connections must always be kept in mind when infection by micro-organisms and the spread of malignant growths is under consideration (Fig. 30).

For the main part the lymph vessels accompany the blood-vessels, but they are much more numerous than the latter; they are present in all tissues, except cartilage; and they contain a colourless fluid called *lymph*, which drains into the smaller lymph vessels from the tissues amidst which they lie. The lymph vessels unite together, like the veins, to form gradually larger and larger vessels, which are however always relatively small as contrasted with blood-vessels, and the lymph they carry finally enters two terminal lymph vessels, the *right lymph duct* and the *thoracic duct*. Both the terminal lymph vessels join big veins at the root of the neck behind the sternal part of the clavicle, the right lymph duct ending in the right innominate vein and the thoracic duct in the left innominate vein. Therefore, eventually, all the lymph gathered from the tissues is poured into the blood. In ordinary circumstances the lymph carries materials which are distributed by the blood throughout the body, to the organs which must utilise them or excrete them in order that the bodily health may be maintained, but if micro-organisms have invaded the tissues or malignant tumours have formed amidst them, the micro-organisms or the poisons they form and cells of the malignant tumours may enter the lymph vessels, and when that occurs it necessarily follows that they may be distributed by the blood to all parts of the body. That naturally occurs rapidly in the cases of any dissolved poisons, but the process may be delayed in the cases of micro-organisms and the cells of malignant tumours, for the lymph glands are interposed, like small filters, in the courses of the lymph vessels, and micro-organisms and malignant cells are frequently caught in them. The micro-organisms so caught may cause inflammation of the glands and the malignant cells develop into new malignant tumour formations. It is important therefore, in the consideration of all cases of micro-organic infection and malignant tumour growth, that the doctor should have a very clear idea of the possible lymph pathways by which the infection or the tumour may spread, and the positions of the lymph glands which may, for a time, retard disaster and give him the opportunity to deal successfully with the conditions which are threatening.

It is probable that all lymph passes through at least one lymph gland before it enters the terminal lymph vessels, and most lymph passes through many glands. The lymph vessels which convey lymph to lymph glands are called *afferent* lymph vessels, and those which convey it from glands are *efferent* lymph vessels. Both the lymph vessels and the lymph glands in the superior extremity, as in other parts of the body, form two main groups, *deep* and *superficial*.

The *deep glands* are: (1) the deep cubital glands; (2) the brachial glands; (3) the axillary glands: (*a*) lateral, (*b*) anterior, and (*c*) posterior (see p. 29); (4) the delto-pectoral glands; (5) in some cases there are a few scattered lymph glands associated with the deep arteries of the front of the forearm.

The lymph from all the structures deep to the deep fascia is carried by lymph vessels which accompany the blood-vessels to the nearest available lymph glands. The deep cubital glands receive the lymph from the deep parts of the hand and forearm, and part of the lymph from the elbow, and pass it on to the brachial glands, which also receive lymph from the elbow and the deep parts of the arm. From the brachial glands the lymph passes to the lateral group of axillary glands.

The *superficial lymph glands* are the superficial cubital glands which lie in the fat of the front of the medial side of the arm immediately proximal to the medial epicondyle (see p. 63).

The lymph from the skin and subcutaneous tissues of the superior extremity forms two main streams. (1) From the palm, the ulnar border and the ulnar part of the dorsal surface of the hand, the greater part of the front, the ulnar border, and the ulnar part of the dorsal surface of the forearm, it flows through a series of superficial lymph vessels which accompany the tributaries and the distal part of the trunk of the basilic vein to the superficial cubital glands. The efferent vessels from the superficial cubital glands, reinforced by lymph vessels from the medial part of the arm, accompany the proximal part of the basilic vein through the deep fascia; some of them end in the brachial glands, but the majority pass to the lateral axillary glands. (2) The second stream flows from the radial part of the dorsal aspect of the hand, the radial border, and the radial part of the posterior surface of the forearm and the lateral part of the arm, through a series of lymph vessels which accompany the cephalic vein. They end in the delto-pectoral glands, which receive lymph also from the region of the shoulder. The lymph from the lateral axillary glands and the delto-pectoral glands passes to the infraclavicular glands, and thence on the right side to the right lymph duct, and on the left side to the thoracic duct.

The lymph from the deep and superficial parts of the scapular region flows mainly to the posterior axillary glands, and through them to the infraclavicular glands. The superficial and deep lymph vessels of the anterior axillary region have already been traced. They carry lymph partly to the anterior axillary and interpectoral glands, whence it passes to the infraclavicular glands, and partly directly to the infraclavicular glands, but they also convey it to the sternal lymph glands, and they communicate with the lymph vessels of the upper and anterior part of the abdomen (see p. 17 and Fig. 14).

When the superficial veins and their connections have been cleaned and studied, the cutaneous nerves of the superior extremity must be found and cleaned; they are:

1. The posterior supraclavicular nerves. 2. The intercosto-brachial nerve. 3. The medial cutaneous nerve of the arm. 4. The lateral brachial cutaneous nerve. 5. The posterior cutaneous nerve of the arm.	To the skin of the arm.
6. The medial cutaneous nerve of the forearm. 7. The dorsal cutaneous nerve of the forearm.	To the skin of the arm and the forearm.
8. The lateral cutaneous nerve of the forearm.	To the forearm and ball of the thumb.
9. The palmar cutaneous branch of the median nerve. 10. The palmar cutaneous branch of the ulnar nerve.	To the skin of the palm.

11. The digital branches of the median nerve.
12. The digital branches of the ulnar nerve.
13. The superficial branch of the radial nerve and its dorsal digital branches.
14. The dorsal branch of the ulnar nerve and its dorsal digital branches.

Dissection.—Turn to the proximal end of the limb and commence with the *intercosto-brachial nerve*, which was severed when the superior extremity was removed from the trunk. It lies in the posterior part of the medial side of the arm, and is at first deep to the deep fascia. Note the point at which it pierces the deep fascia (Figs. 31, 32) and trace it to its termination near the elbow. By means of its various branches it supplies the skin on the medial side of the posterior part of the arm (Figs. 31, 32).

Find, next, the *medial cutaneous nerve of the arm*. It pierces the deep of the fascia proximal third of the arm on the medial side, and its branches supply the skin as far as the elbow in an area anterior to that supplied by the intercosto-brachial nerve.

After the medial cutaneous nerve of the arm has been cleaned, look for the branches of the *medial cutaneous nerve of the forearm*, which supply the medial part of the skin of the arm. They vary in number and size, but they usually pierce the deep fascia along the line of the medial border of the biceps brachii and they communicate with one another (Fig. 31).

The trunk of the medial cutaneous nerve of the forearm either pierces the deep fascia close to the basilic vein, or it passes through the same opening as the vein, and divides into its *volar* and *ulnar terminal branches*. The volar branch passes either deep or superficial to the median cubital vein and then descends to the wrist. It supplies the skin of the ulnar half of the volar aspect of the forearm. The ulnar branch passes either anterior or posterior to the medial epicondyle and then along the ulnar margin of the forearm. It supplies the skin of the ulnar margin and of the ulnar part of the dorsum of the forearm as far as the wrist.

After the medial cutaneous nerve of the forearm has been dissected, trace the remains of the posterior supraclavicular nerves through the fat over the proximal part of the deltoid; they supply the skin over the proximal half of the deltoid muscle. When they have been traced to their terminations make an incision through the fat along the distal half of the posterior border of the deltoid and secure the *lateral cutaneous nerve of the arm*. It is a branch of the axillary nerve and will be found turning round the posterior border of the deltoid at the junction of the proximal two-thirds with the distal-third of the muscle (Figs. 31, 32, 33). It runs forwards across the muscle and supplies the skin over its distal half.

To find the *proximal* and *distal branches* of the *dorsal cutaneous nerve of the forearm* dissect in the fat between the lateral epicondyle of the humerus and the insertion of the deltoid. They are branches of the radial nerve and both are occasionally difficult to find. The proximal branch usually pierces the deep fascia a little distal to the insertion of the deltoid (Figs. 31, 32). It supplies the skin of the lateral part of the anterior aspect of the arm as far as the elbow. The distal branch will be found about one inch nearer the lateral epicondyle. It passes behind the lateral epicondyle and then descends along the dorsal aspect of the forearm to the wrist.

After the distal branch of the dorsal cutaneous nerve of the forearm has been traced to its termination, find the *lateral cutaneous nerve of the forearm*. It is the continuation of the musculo-cutaneous nerve. It appears at the lateral border of the biceps under cover of the cephalic vein, about 25 mm. above the point where the medial cubital vein leaves the cephalic vein. Soon after it enters the superficial fascia it divides into a volar and a dorsal branch. The volar branch descends along the radial part of the volar aspect of the forearm to the ball of the thumb, and the dorsal branch may be traced distally on the dorsal aspect of the radial side of the forearm as far as the wrist.

The *posterior cutaneous nerve of the arm* was found during the dissection of the axilla springing from the proximal part of the radial nerve. Now it must be traced along the dorsal aspect of the arm to the elbow. It supplies the skin of the dorsum of the arm from the axilla to the elbow (Fig. 32).

After the posterior cutaneous nerve of the arm has been cleaned, place the limb on its dorsal surface and look for the palmar cutaneous branches of the median and ulnar nerves.

They both pierce the deep fascia of the forearm about 30 mm. proximal to the wrist. The *palmar cutaneous branch of the median nerve* lies in the line of the medial border of the proximal end of the ball of the thumb (thenar eminence) and it extends to the middle of the palm. The *palmar cutaneous branch of the ulnar nerve* lies in the line of the middle of the ball of the little finger (hypothenar eminence); it also extends to the level of the middle of the palm (Fig. 31).

After the distribution of the palmar cutaneous nerves has been seen clear away the superficial fascia of the palm from the interval between the thenar and hypothenar eminences to the bases of the digits to expose the intermediate part of the *palmar aponeurosis,* that is, the deep fascia of the palm. Note that the superficial fascia in the area under consideration is dense. It is divided into small lobules by fibrous septa which pass from the skin to the palmar aponeurosis. When the intermediate part of the palmar aponeurosis is exposed it will be found to be triangular in outline. The apex lies at the wrist where it is continuous with the deep fascia of the forearm. The base is at the level of the distal ends of the metacarpal bones, and it divides into five pieces, one for each finger and a less definite slip for the thumb. A bundle of transverse fibres will be met with in the fold of skin which crosses the proximal ends of the interdigital clefts. It is the *superficial transverse ligament* of the hand, and it must be divided opposite the clefts in order that the volar digital nerves which supply the adjacent sides of the clefts may be followed.

The volar digital nerves are seven in number. The first and second pass to the thumb, one to its radial and one to its ulnar side. They are accompanied by branches of the princeps pollicis artery. They will be found at the medial margin of the thenar eminence and must be traced to the end of the thumb. The third appears at the lateral margin of the slip of the palmar aponeurosis to the index-finger. It runs along the radial side of the finger accompanied by the volar radialis indicis artery. The fourth, fifth, and sixth will be found between the slips of the intermediate part of the palmar aponeurosis in line with the first, second, and third interdigital clefts respectively. Each is accompanied by a volar digital artery, and like the artery it divides to supply the adjacent sides of the fingers which bound the cleft opposite which it lies. The seventh supplies the ulnar side of the little finger. It appears at the distal border of the palmaris

PLATE III

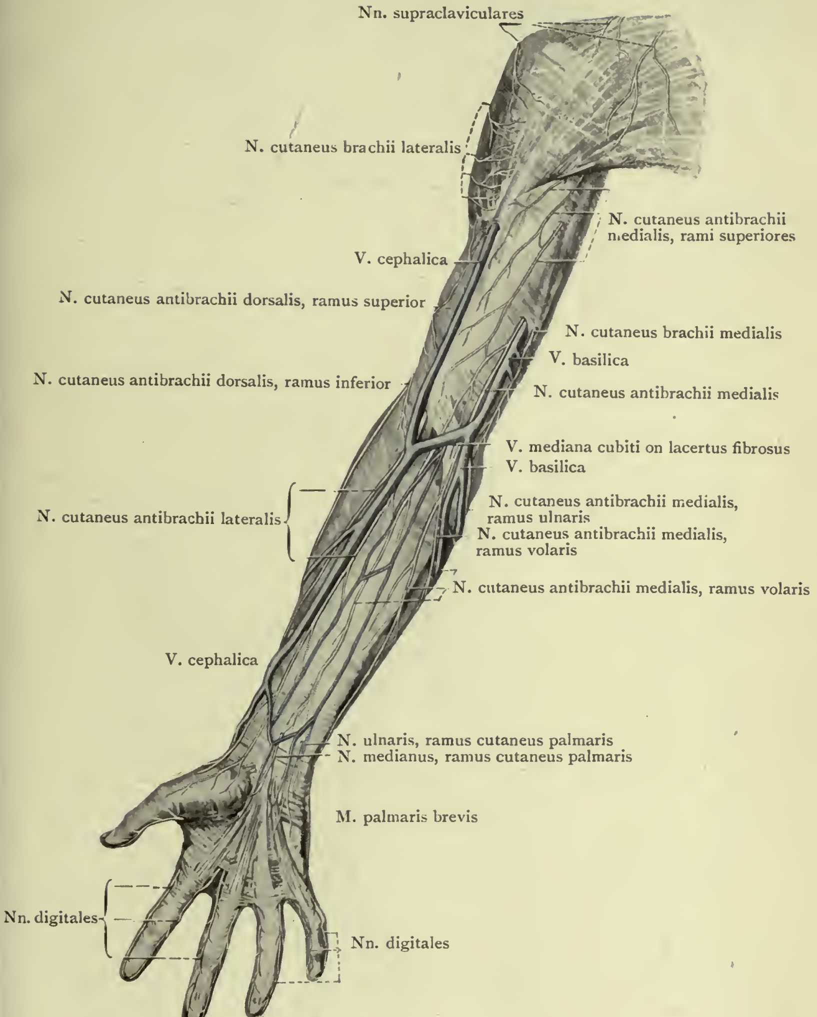


FIG. 31.—Superficial Nerves and Veins of the Anterior Aspect of the Superior Extremity.

PLATE IV

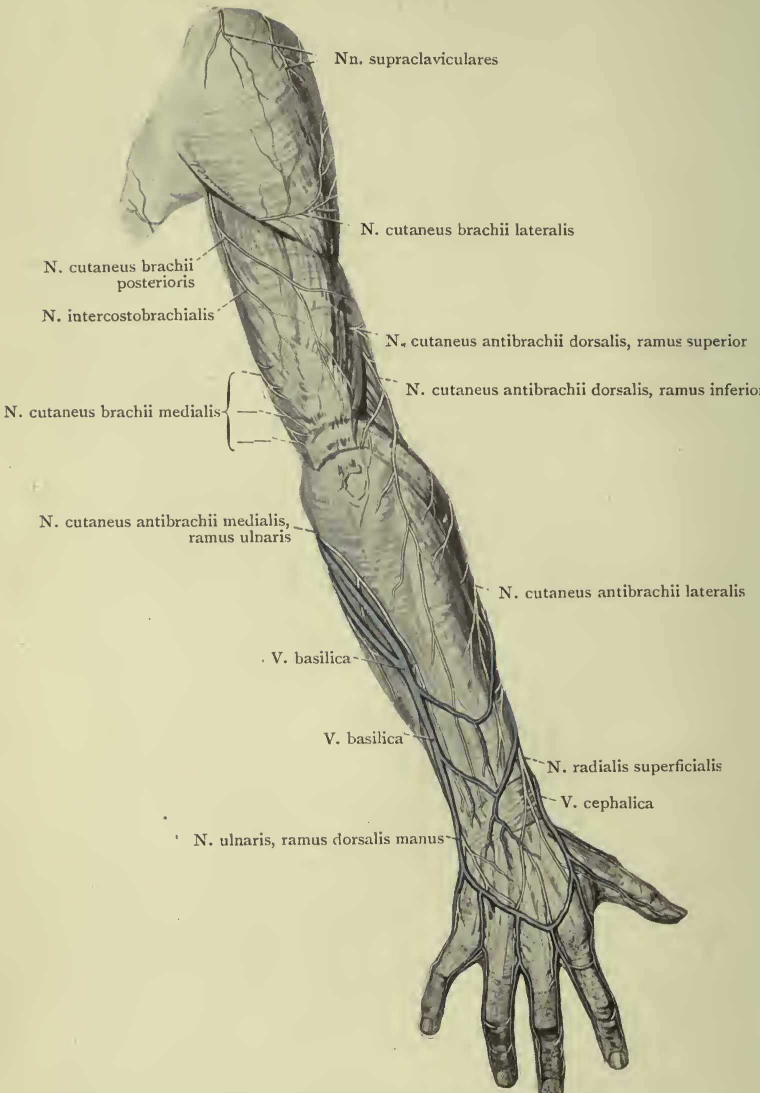


FIG. 32.—Superficial Veins and Nerves of the Posterior Aspect of the Superior Extremity.

brevis muscle and is accompanied by a digital artery. The five most lateral digital nerves are branches of the median nerve, the two most medial are branches of the ulnar nerve, therefore the median nerve supplies three and a half digits, the thumb, the index, the middle and half the ring digit, and the ulnar supplies the remaining one and a half, viz., the little finger and half the ring finger.

As the branches of the median nerve to the fingers are followed along the fingers they will be found to send branches not only to the volar surfaces but also to the dorsal surfaces in the regions of the second and terminal phalanges.

The careful dissector will note that some of the finer branches of the digital nerves terminate in minute ovoid bodies embedded in the fat. They are the Pacinian touch corpuscles and are associated with the sense of touch.

Two other cutaneous nerves have still to be dissected; they are the dorsal branch of the ulnar nerve and the superficial division of the radial nerve. Both are distributed to the dorsum of the hand and to the dorsal aspects of the digits.

The *dorsal branch of the ulnar nerve* must be sought for as it turns round the ulnar border of the wrist immediately distal to the styloid process of the ulna. It gives a branch to the ulnar side of the little finger and a branch to supply the adjacent sides of the ring and little fingers; the latter communicates with the most medial branch of the superficial division of the radial nerve.

The *superficial branch of the radial nerve* will be found at the radial border of the forearm. It appears from under cover of the tendon of the brachio-radialis about 8 cm. (3¼ inches) above the wrist, and, as it descends to the hand, it breaks up into five branches;—one to each side of the thumb, one to the radial side of the index-finger, one to the adjacent sides of the index and middle fingers, and one to the adjacent sides of the middle and ring fingers. The last branch is connected with the adjacent ramus of the dorsal branch of the ulnar nerve by a communicating twig. A palmar cutaneous branch is distributed to the ball of the thumb either from the trunk of the superficial part of the radial nerve or from the branch to the radial side of the thumb. The dorsal digital nerves of the thumb can be traced to the end of the thumb, those of the index digit to the proximal end of the second phalanx, those of the middle finger to the middle of the second phalanx and those of the ring and little fingers to the proximal end of the terminal phalanx. The remaining parts of the dorsal aspects of the fingers are supplied by the volar digital nerves. The important practical point is that parts of the dorsal surface of the index, middle, and ring digits are supplied not by the radial but by the median nerve.

The arrangement of the nerves on the dorsum of the hand is very variable. That described above is usually met with, but not uncommonly the ulnar nerve supplies a larger and the radial nerve a smaller area. The reverse arrangement is also found.

When the dissection of the cutaneous nerves of the superior extremity is completed remove the remains of the fatty superficial fascia and proceed to the study of the deep fascia.

Deep Fascia.—The deep fascia of the superior extremity consists chiefly of transverse fibres, which are bound together by oblique and longitudinal fibres. The oblique and longitudinal fibres become specially developed in certain situations which will be noted later. The deep fascia is fairly strong in the region of the shoulder over the deltoid muscle. Over the posterior part of the deltoid and the adjoining part of the infraspinatus, which covers the lower part of the back of the scapula, it becomes dense, and it is closely attached by deep processes to the axillary border of the scapula. Over the front of the arm, where it covers the biceps muscle, it is thin, but it is much stronger at the back of the arm, over the triceps. On each side, extending proximally from the lateral and the medial epicondyles deep expansions bind it to the lateral and medial supra-epicondylar ridges of the humerus. The expansions are known as the *lateral* and *medial intermuscular septa*, because they separate the muscles on the front from those at the back of the arm. At the elbow it is thickened and strengthened by tendinous fibres, which pass to it from the biceps and triceps muscles, and it is closely attached to the lateral and medial epicondyles of the humerus and to the olecranon of the ulna. A special thickening called the *lacertus fibrosus* (Fig. 31) is found at the front of the elbow. It extends from the medial border of the proximal part of the biceps tendon and the adjacent part of the muscle to the medial side of the proximal part of the forearm. It separates the median cubital vein, which lies superficial to it, from the brachial artery, which is deep to it. The volar branch of the medial cutaneous nerve of the forearm usually passes between the lacertus fibrosus and the median cubital vein.

In the forearm the deep fascia is strong over the proximal parts of the muscles which spring from the medial and the lateral epicondyle. Then it becomes thin, especially on the volar aspect. On the dorsal aspect it is bound to the whole length of the posterior border of the ulna by a deep extension which intervenes between the muscles on the dorsal and volar parts of the medial side of the forearm.

At the wrist the transverse fibres of the deep fascia become very obvious, and they form two marked transverse bands; one on the volar aspect called the *transverse carpal ligament* and one on the dorsal aspect called the *dorsal carpal ligament.*

Both the bands are bound to the adjacent bones and they act as straps which bind down the tendons, which pass deep to them, and prevent them from springing away from the bones when the hand is bent volarwards or dorsally.

The transverse carpal ligament is attached on the ulnar side to the pisiform bone and the hook of the hamatum, and on the radial side to the tubercle of the navicular bone and the ridges on the volar surface of the multangulum majus.

Five structures cross the superficial aspect of the transverse carpal ligament: (1) the ulnar artery; (2) the ulnar nerve; (3) the palmar cutaneous branch of the ulnar nerve; (4) the palmar cutaneous branch of the median nerve; (5) the tendon of the palmaris longus. The palmar cutaneous branches of the median and ulnar nerves have already been seen. The ulnar artery and nerve pierce the deep fascia proximal to the transverse carpal ligament, pass across its superficial surface close to the lateral side of the pisiform bone and disappear deep to the palmaris brevis. As they cross the ligament they are bound down to it by a slip of fascia, called the *volar carpal ligament*, which passes from the pisiform bone to the superficial surface of the transverse carpal ligament. The tendon of the palmaris longus pierces the deep fascia proximal to the transverse carpal ligament, crosses it and blends with the apex of the intermediate part of the palmar aponeurosis which is attached to the distal border of the ligament.

Distal to the transverse carpal ligament the deep fascia is called the *palmar aponeurosis*, of which there are three parts. (1) A relatively thin lateral part which covers the muscles of the thenar eminence; (2) a relatively thin medial part over the muscles of the hypothenar eminence; and (3) a strong intermediate part which conceals and protects the main vessels, nerves, and the tendons passing to the fingers. The lateral and medial parts consist mainly of transverse fibres; the intermediate part on the other hand is formed principally by strong longitudinal fibres bound together by transverse fibres.

The *intermediate part of the palmar aponeurosis* is triangular in outline. Its apex blends with the tendon of the palmaris longus and the transverse carpal ligament. Its borders blend with the thinner lateral and medial parts, and from them septa, which will be dissected later, pass into the depths of the palm. The distal margin or base lies at the level of the heads of the metacarpal bones, and it divides into five proçesses, one for each finger and a more slender process for the thumb. Each process passes to the corresponding digit where it blends with the volar surface of the sheath of the flexor tendons, and it sends a process on each side of the digit which join the deep fascia on the dorsal surface.

The *dorsal carpal ligament* is attached on the radial side to the volar margin of the styloid process of the radius and on the ulnar side to the fascia on the medial side of the wrist. The space between it and the distal ends of the radius and ulna is divided into six compartments by septa, which pass from its deep surface to the ridges on the radius and to the head and styloid process of the ulna. The compartments transmit the tendons which pass from the dorsum of the forearm to the dorsum of the hand and to the dorsal aspects of the fingers. Its superficial surface is crossed by the terminal branches of the superficial division of the radial nerve and by the cephalic and basilic veins. The distal border of the dorsal carpal ligament is continuous with the thin deep fascia of the hand, which is prolonged into the dorsal aspects of the digits.

When the study of the deep fascia of the superior extremity has been completed return to the shoulder region; verify again the attachments of the muscles which connected the scapula and the clavicle with the trunk; afterwards cut away the superfluous parts of the muscles, leaving about one inch of each for revision. Then proceed to the general study of the shoulder region.

Muscles inserted into the Clavicle and Scapula.—The insertions of the muscles which have already been divided must first engage the attention of the student. They should be carefully defined and the precise extent of each studied. Begin with the *omo-hyoid*, which springs from the superior border of the scapula; then deal in the same way with the *levator scapulæ*, *rhomboideus minor* and *major*, which are attached to the vertebral border of the bone, and the *serratus anterior*, which is inserted into the costal aspect of the medial and inferior angles, and the intervening portion of the vertebral border of the scapula. The insertion of the *pectoralis minor* into the coracoid process, and of the *trapezius* into both clavicle and scapula, should also be thoroughly re-examined.

SHOULDER—SCAPULAR REGION.

In the dissection of this region the following parts must be studied:—

1. Cutaneous nerves of the shoulder.
2. Deep fascia.
3. Deltoid muscle.
4. Sub-acromial bursa.
5. Anterior and posterior circumflex vessels of the humerus.
6. Axillary (circumflex) nerve.
7. Circumflex scapular artery.
8. Subscapularis muscle.
9. Supraspinatus, infraspinatus, teres minor, and teres major muscles.
10. Bursæ in connection with the shoulder-joint.
11. Suprascapular nerve and transverse scapular artery.
12. Acromio-clavicular joint, and the coraco-acromial arch.

Nervi Cutanei (Cutaneous Nerves).—The nerves which lie in the superficial fascia of the shoulder region are derived from two different sources. They are:—

1. Posterior supraclavicular nerves from the third and fourth cervical nerves.
2. Cutaneous branches from the axillary nerve (circumflex).

They have already been secured and cleaned.

The *posterior supraclavicular nerves* cross the lateral third of the clavicle and the insertion of the trapezius, under cover of the platysma. They were divided when the limb was removed, and the distal ends have been followed over the proximal half of the deltoid.

The *cutaneous branches* of the *axillary nerve* consist—(*a*) of a large branch, the *lateral cutaneous nerve of the arm*, which turns round the posterior border of the deltoid muscle, and (*b*) of several fine filaments which pierce the substance of the deltoid muscle, and appear at irregular intervals on its surface (Fig. 33). The latter are difficult to secure, but the lateral brachial cutaneous nerve has already been found and cleaned (see p. 69). It turns round the posterior border, and is distributed over the distal part of the deltoid region.

Deep Fascia.—It has already been noted that the deep fascia over the deltoid is fairly strong, and that as it passes from the deltoid to the muscles which spring from the lower part of the posterior aspect of the scapula, it becomes strong and dense over the infraspinatus, the teres minor and the teres major. In the lower scapular region it is firmly attached to the limits of the infraspinous fossa in which the infraspinatus takes origin, and it presents other very apparent connections. Thus, a strong septum, proceeding from its

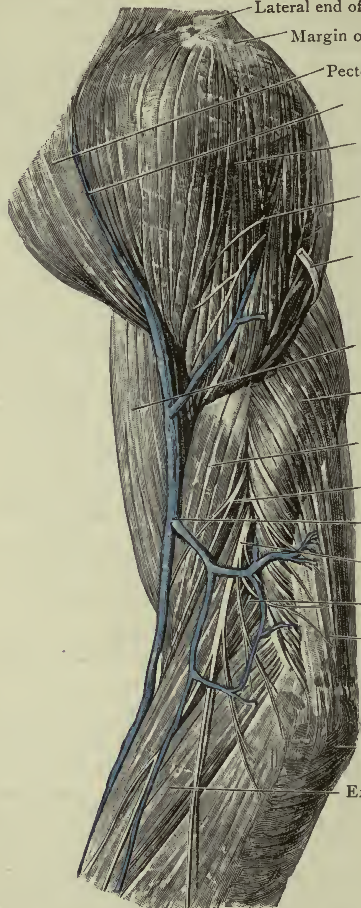


FIG. 33.—The Deltoid Muscle and the lateral aspect of the Arm.

deep surface, will be noticed to dip in between the infraspinatus and teres minor muscles, and then, as it proceeds forwards, it gives a thin covering to the teres minor, teres major, and the deltoid. Indeed, it may be said to split into two lamellæ—a superficial and a deep,—which, as they pass forwards, enclose between them the deltoid muscle.

Dissection.—Place a small block in the axilla, fix the scapula to it with hooks and bend the arm over the block to make the fibres of the deltoid tense. Detach the lateral brachial cutaneous branch of the axillary nerve from the deep fascia, and turn it backwards to the point where it curves round the posterior border of the deltoid; then clean the deltoid. On the left side commence at its posterior border, make an incision through the deep fascia along the whole length of that border and reflect the deep fascia forwards. On the right side commence in front, where the fascia has already been partly reflected during the dissection of the axillary region, and reflect the fascia backwards.

M. Deltoideus.—The deltoid muscle is composed of short, coarse fasciculi, and as its name implies it is of triangular form. Its proximal end or base arises: (1) from the anterior border and the adjacent part of the upper surface of the lateral third of the clavicle; (2) from the lateral border of the acromion; and (3) from the inferior lip of the posterior border of the spine of the scapula. Its origin corresponds closely with the insertion of the trapezius. Its fasciculi converge rapidly as they pass distally to the pointed tendinous insertion on the rough *deltoid tubercle* situated in the middle of the antero-lateral surface of the body of the humerus (Fig. 45). The muscle is an abductor, and a medial and lateral rotator of the humerus, and it is supplied by branches of the anterior division of the axillary nerve which enter its deep surface.

Dissection.—Place the limb on its posterior aspect. Release the axillary vessels, and the nerves, from the coracoid process and clean the angle between the humerus and the scapula. Follow the axillary nerve and the posterior circumflex humeral artery backwards. They will be found to enter a cleft between the subscapularis above and the teres major below. Separate those muscles and a triangular interval will be displayed. It is bounded laterally by the surgical neck of the humerus. Crossing the space from above downwards, behind the subscapularis and the teres major is the long head of the triceps. It divides the triangular interval into a lateral part called the *quadrangular space* and a medial part called the *triangular space*. The axillary nerve and the posterior humeral circumflex artery pass through the quadrangular space. Now reverse the limb, push the posterior border of the deltoid forwards and find the axillary nerve and the posterior humeral circumflex artery. They emerge from the quadrangular space and pass forwards round the lateral surface of the surgical neck of the humerus.

At this stage of the dissection the deltoid muscle must be reflected. Cut it away from its origin from the clavicle, acromion, and spine of the scapula, and turn it towards its insertion into the humerus, taking care not to injure the circumflex humeral arteries and the axillary nerve. Note the tendinous intersections which run through the substance of the muscle, then clean the vessels and nerves which are exposed. The axillary nerve enters the back part of the shoulder region through the posterior part of the quadrangular space, accompanied by the posterior humeral circumflex vessels, and at once divides into an anterior and a posterior division. Before it divides, whilst it is in the quadrangular space, immediately below the shoulder-joint, it gives off an articular twig to the joint, which should be secured. The anterior division accompanies the posterior humeral circumflex artery round the surgical neck of the humerus. It supplies the deltoid and sends branches through it to the skin on its superficial surface. Clean both the nerve and the vessel; then turn to the posterior branch and secure the twig to the teres minor muscle, upon which there is a gangliform enlargement. The posterior branch terminates as the lateral cutaneous nerve of the arm, which turns round the posterior border of the deltoid to gain its superficial surface. It has already been dissected (see p. 69). Clean the teres major and minor muscles which spring from the posterior surface of the axillary border of the scapula, and pass to the humerus, and note the strong septum of deep fascia which separates them. Clean the long head of the triceps which arises from the upper part of the axillary border of the scapula. Then examine the subacromial bursa, which lies directly below the acromion, on the insertion of the supraspinatus. If the wall of the bursa is quite entire a blow-pipe may be thrust into it. It can then be distended, and if unilocular it may be inflated to about the average size of a hen's egg. It varies much in size, however, in different subjects. Open the bursa and examine its extent with the finger or a blunt probe. Its interior is sometimes divided by fibrous partitions into two or more loculi. Now turn the limb on to its posterior aspect and clean the proximal parts of the coraco-brachialis and the short head of the biceps brachii which spring, by a common tendon, from the tip of the coracoid process of the scapula. Pull the short head of the biceps and the coraco-brachialis medially and expose the tendon of the long head of the biceps lying in the intertubercular sulcus of the humerus, but do not displace it at present. Now pull the short head of the biceps and the coraco-brachialis laterally and clean the insertion of the subscapularis — it is inserted into the lesser tubercle of the humerus on the medial side of the intertubercular sulcus. Clean also the anterior humeral circumflex artery, trace it to its division into an ascending branch, which runs to the shoulder-joint along the intertubercular sulcus, and a transverse branch, which anastomoses with the posterior humeral circumflex artery, and then re-examine the structures which lie directly under cover of the deltoid and note their relative positions.

Parts under Cover of the Deltoid.—The deltoid covers the proximal part of the humerus, and envelops the region of the shoulder-joint behind, laterally, and in front. It also covers the coracoid process of the scapula. It is separated from the shoulder-joint by the muscles which are attached to the proximal end of the humerus and by the subacromial bursa. The full, rounded appearance of the shoulder is due to the deltoid passing over the proximal end of the humerus and the muscles attached to it. When the head of the humerus is dislocated the muscle passes vertically

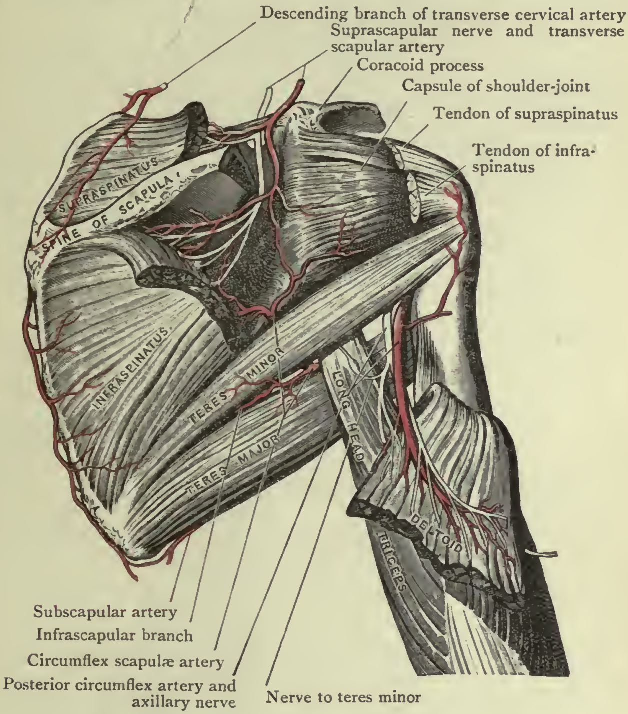


FIG. 34.—Dissection of the Posterior Scapular Region.

from its origin to its insertion, and the dislocation is recognised by the squareness or flatness of the shoulder. Under cover of the posterior part of the deltoid are portions of the muscles which spring from the posterior surface of the scapula, viz., the infraspinatus, teres major, and teres minor, and the proximal part of the long head of the triceps, which arises from the upper part of the axillary border of the scapula. Under its middle part lie the insertion of the supraspinatus, covered by the subacromial bursa, and the upper portion of the lateral aspect of the body of the humerus. Its anterior part covers the coracoid process and

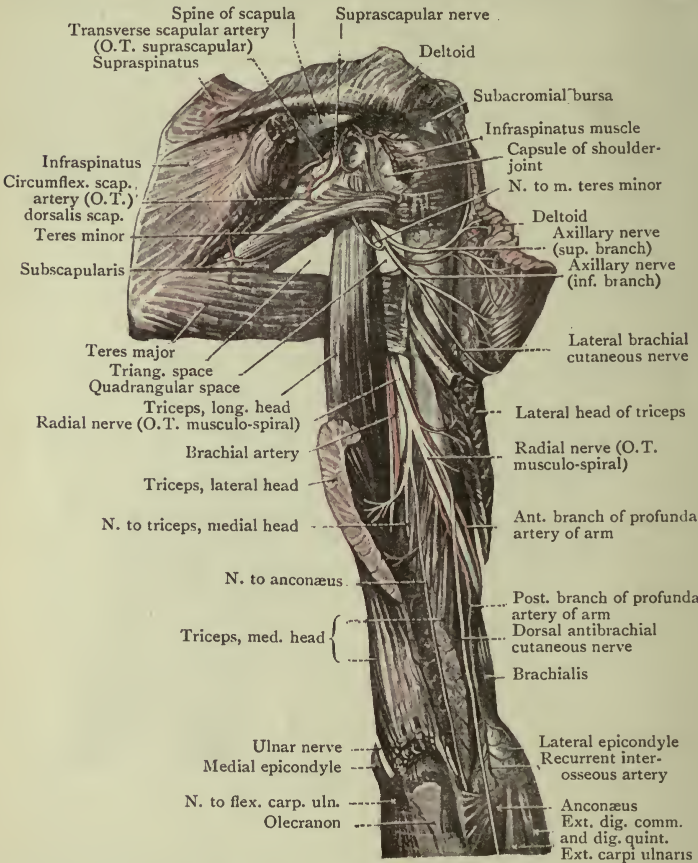


FIG. 35.—Dissection of the dorsal aspect of the Arm. The lateral head of the Triceps has been divided and turned aside to expose the sulcus on the Humerus for the radial nerve.

the muscles and ligaments which are attached to it, the long head of the biceps muscle descending in the intertubercular sulcus, and the insertion of the subscapularis into the lesser tubercle of the humerus. The muscle also covers the greater part of the axillary nerve and the anterior and posterior humeral circumflex vessels.

Bursa Subacromialis.—The subacromial bursa is a large bursal sac which intervenes between the acromion and deltoid above, and the muscles which immediately cover the upper aspect of the capsule of the shoulder-joint below. It facilitates the play of the proximal end of the humerus and the

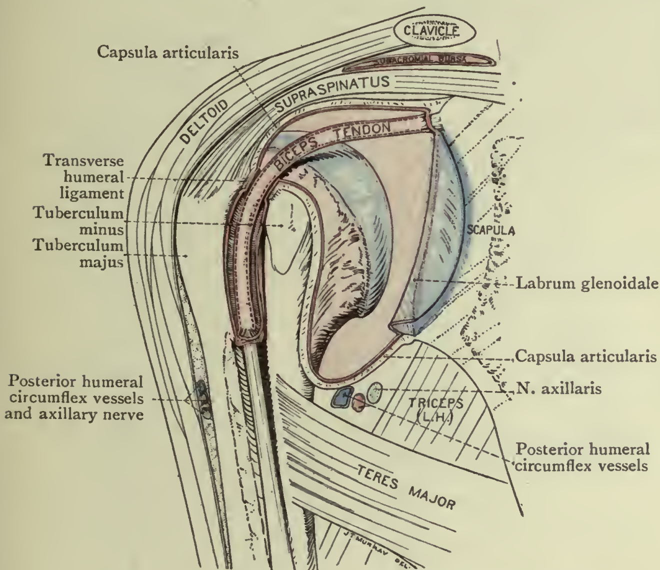


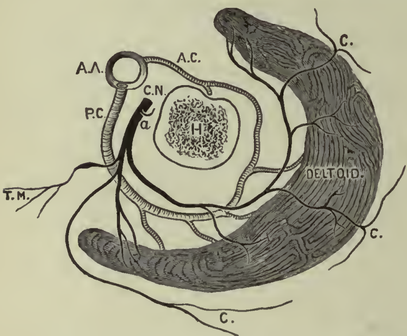
FIG. 36.—Diagram of a Frontal Section of the Right Shoulder.

attached muscles on the under aspect of the acromion and deltoid.

The Quadrangular and Triangular Spaces.—Neither of these so-called spaces has any real existence until the boundaries are artificially separated from one another. When viewed from the front the triangular space is bounded above by the subscapularis, below by the teres major, and laterally by the long head of the triceps, but at the back the teres minor replaces the subscapularis as the upper boundary. The circumflex scapular branch of the subscapular artery enters the space from the front, turns round the axillary border of the scapula, anterior to the teres minor, and enters the infraspinous fossa.

The boundaries of the quadrangular space, as seen from the front, are the subscapularis above, the teres major below, the long head of the triceps medially, and the surgical neck of the humerus laterally. At the back the teres minor replaces the subscapularis as the upper boundary. Between the subscapularis anteriorly, and the teres minor posteriorly, the inferior surface of the capsule of the shoulder-joint forms the upper boundary of the space, and through the space, directly below the capsule, pass the axillary nerve and the posterior humeral circumflex vessels.

Arteriæ Circumflexæ Humeri (O.T. Circumflex Arteries).—The *posterior humeral circumflex artery* has been already



H. Transverse section of the humerus immediately distal to the tubercles.
A.A. Axillary artery.
P.C. Posterior circumflex artery of the humerus.
A.C. Anterior circumflex artery of the humerus.
C.N. Axillary nerve.
a. Articular branch.
T.M. Branch to teres minor.
C. Cutaneous branches.

FIG. 37.—Diagram of the Circumflex Vessels and the Axillary Nerve.

observed to arise, within the axilla, from the posterior aspect of the axillary artery, a short distance distal to the subscapular branch. It at once passes backwards, through the quadrilateral space, and, winding round the surgical neck of the humerus, it is distributed in numerous branches to the deep surface of the deltoid muscle. Several twigs are given also to the shoulder-joint and the integument. It anastomoses with the acromial branch of the thoraco-acromial artery and with the anterior humeral circumflex artery, and also, by one or more twigs, which it sends distally to the long head of the triceps, with the profunda branch of the brachial artery.

The termination of the *anterior humeral circumflex artery* can now be more satisfactorily studied, and its anastomosis with the posterior humeral circumflex artery established, if the injection has flowed well. By the anastomosis the arterial ring which encircles the proximal part of the humerus is completed.

Nervus Axillaris (O.T. **Circumflex Nerve**).—The axillary

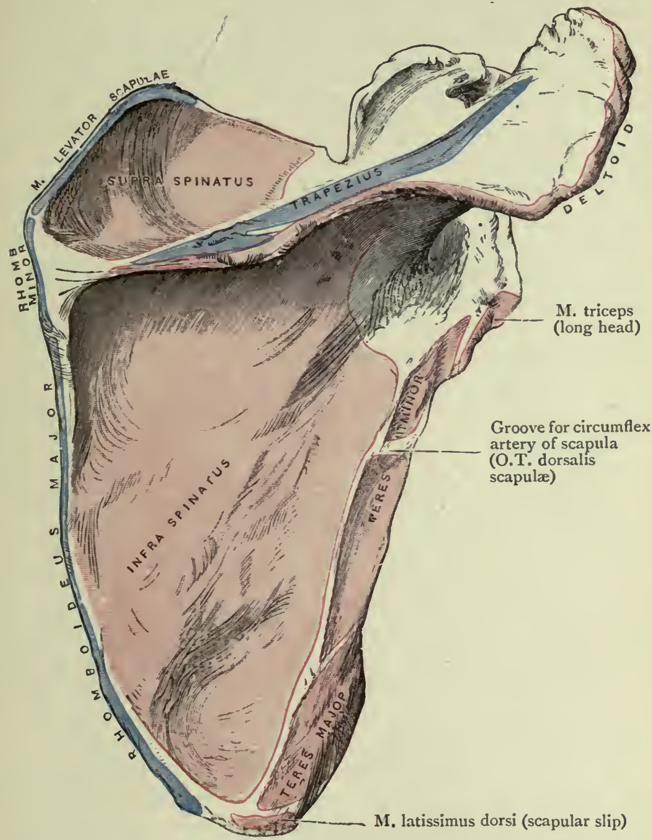


FIG. 38.—Dorsum of Scapula with the Attachments of the Muscles mapped out.

nerve accompanies the posterior humeral circumflex artery. It supplies: (1) an *articular twig* to the shoulder-joint; (2) *muscular branches* to the deltoid and teres minor; and (3) *cutaneous branches* to the skin over the distal part of the deltoid. It springs from the posterior cord of the brachial plexus, turns round the lower border of the subscapularis, and passes backwards, with the posterior humeral circumflex artery, through the quadrilateral space to the back of the limb. There it divides into an anterior and a posterior division. The *articular branch* takes origin from the trunk of the nerve in the quadrilateral space, and enters the joint from below. The *posterior division* gives off the branch to the teres minor, and, after furnishing a few twigs to the posterior part of the deltoid, is continued onwards, as the *lateral cutaneous nerve of the arm*, which has already been dissected in the superficial fascia over the distal part of the deltoid (Figs. 31, 32, 35). The nerve to the teres minor is distinguished by the presence of an oval, gangliform swelling upon it.

The *anterior division* proceeds round the humerus with the posterior circumflex artery of the humerus, and ends near the anterior border of the deltoid. It is distributed, by many branches, to the deep surface of the muscle, whilst a few fine filaments pierce the deltoid and reach the skin.

> ***Dissection.***—Clean the coraco-acromial ligament, which extends from the coracoid process to the acromion. Note that the coracoid process, the coraco-acromial ligament, and the acromion form an arch—the *coraco-acromial arch.* The arch lies above the shoulder-joint, but is separated from it by the subacromial bursa, and the humeral ends of the supraspinatus, the infraspinatus, and the subscapularis.

Arcus Coracoacromialis.—The coraco-acromial arch should be examined at the present stage, in order that its relationship to the subacromial bursa and the supraspinatus may be appreciated. It is the arch which overhangs the shoulder-joint and protects it from above. It is formed by the coracoid process, the acromion, and a ligament—the coraco-acromial—which stretches between them.

The *coraco-acromial ligament* is a strong band of a some what triangular shape. By its base it is attached to the lateral border of the coracoid process, whilst by its apex it is attached to the extremity of the acromion (Figs. 51, 52, 54).

The coraco-acromial arch plays a very important part in the mechanism of the shoulder; it might almost be said to form a secondary socket for the humerus. The large sub-acromial bursa, which intervenes between the acromion and the muscles immediately covering the capsule of the shoulder-joint, facilitates the movements of the proximal end of the humerus on the inferior surface of the arch; it has already been noted (p. 78).

Dissection.—Clear away the subacromial bursa and clean the supraspinatus, following it below the coraco-acromial arch to its insertion into the greater tubercle of the humerus. Then clean the fascia from the surface of the subscapularis; it is a fairly strong fascia and, near the vertebral border of the scapula, some of the fibres of the serratus anterior are usually inserted into it. Now turn the limb on its anterior aspect and remove the strong fascia which covers the posterior surfaces of the infraspinatus, the teres minor and the teres major. Divide first the fascia over the infraspinatus. Incise it from the vertebral border of the scapula to the greater tubercle of the humerus. Reflect the upper part to its attachment to the spine of the scapula and the lower part to the septum which separates the infraspinatus from the teres minor and major muscles. Then clear the fascia from the teres minor and major muscles. As the septum between the teres minor and the infraspinatus is being investigated be careful to avoid injury to the circumflex scapular artery. The scapular muscles may now be examined.

M. Supraspinatus.—The supraspinatus muscle arises from the medial two-thirds of the supraspinous fossa, and also, to a slight degree, from the supraspinous fascia, which covers it. From this origin the fibres converge, as they pass laterally, and, proceeding under the acromion, they end in a short, stout tendon, which is inserted into the uppermost of the three impressions on the greater tubercle of the humerus (Fig. 45, p. 107). The tendon is closely adherent to the capsule of the shoulder-joint. A portion of the supraspinatus is covered by the trapezius, and in the loose fat which intervenes between that muscle and the supraspinous fascia some twigs of the ascending branch of the transverse cervical artery ramify. The supraspinatus is supplied by the *suprascapular nerve*; and it is an abductor of the arm.

M. Infraspinatus.—The infraspinatus muscle arises from the whole of the infraspinous fossa, with the exception of a small part of it near the neck of the scapula. It derives fibres also from the fascia which covers it. Its tendon of insertion is closely adherent to the capsule of the shoulder-joint, and is attached to the middle impression on the greater tubercle of the humerus (Fig. 48, p. 113). It is supplied by the *suprascapular nerve*; and it is an adductor and lateral rotator of the arm.

M. Teres Minor.—The teres minor is the small muscle which lies along the lower border of the infraspinatus. It arises from an elongated flat impression on the dorsal aspect of the axillary border of the scapula, and from the fascial septa which intervene between it and the two muscles between which it lies, viz. the infraspinatus and teres major. It is inserted into the lowest of the three impressions on the greater tubercle of the humerus, and also, by fleshy fibres, into the body of the bone for about 12.5 mm. (half an inch) distal to the tubercle (Fig. 48, p. 113). As it approaches its insertion it is separated from the teres major by the long head of the triceps brachii. The teres minor is supplied by a branch from the *axillary nerve*. It is an adductor and lateral rotator of the arm.

M. Teres Major.—The part which the teres major plays in the formation of the quadrilateral and triangular spaces has already been seen. It arises from the oval surface on the dorsum of the scapula close to the inferior angle of the bone (Fig. 38, p. 83), and also from the septum which the infraspinous fascia sends in to separate it from the infraspinatus and teres minor muscles. It is inserted into the medial lip of the intertubercular sulcus on the proximal part of the humerus (Fig. 45, p. 107). It is supplied by the lower subscapular nerve, and it is an adductor, a medial rotator and an extensor of the arm.

M. Subscapularis.—The subscapularis muscle arises from the whole of the subscapular fossa, with the exception of a small portion near the neck of the scapula; it takes origin also from the groove which is present on the costal aspect of the axillary border of the bone (Fig. 24, p. 46). Its origin is strengthened by tendinous intersections, which are attached to the ridges on the costal surface of the scapula. The fleshy fibres thus derived converge upon a stout tendon, which is inserted into the lesser tubercle of the humerus; a few of the lower fibres, however, gain independent insertion into the body of the humerus distal to the tubercle (Fig. 45).

As the muscle proceeds laterally to its insertion, it passes under an arch formed by the coracoid process and the conjoined origin of the short head of the biceps brachii and the coraco-brachialis. The subscapularis is supplied by the *upper* and *lower subscapular nerves*. It is an adductor and medial rotator of the arm.

Dissection.—Pull the long head of the biceps out of the intertubercular sulcus. Separate the tendon of insertion of the latissimus dorsi from the anterior surface of the teres major, noting the small fibrous slip which passes from its inferior margin to the fascia on the long head of the triceps muscle (Fig. 16); then follow the tendon of the latissimus to its insertion into the floor of the intertubercular sulcus. The tendon of the latissimus is more or less adherent to the teres major, but near the humerus a small bursa frequently intervenes between the two tendons. Now examine carefully the insertions of the pectoralis major, the latissimus dorsi and the teres major.

Insertions of the Pectoralis Major and Latissimus Dorsi.—As the pectoralis major passes to its insertion into the lateral lip of the intertubercular sulcus it lies anterior to the great vessels and nerves of the axilla, to the two heads of the biceps humeri, and to the coraco-brachialis, whilst the latissimus dorsi lies behind those structures. The teres major accompanies the latissimus dorsi as far as the medial lip of the intertubercular sulcus. It therefore does not pass behind the long head of the biceps humeri.

The tendon of the *pectoralis major* consists of two laminæ. A separation of the clavicular and sternal portions of the muscle will bring both laminæ into view, and the following points should be noted in connection with them: (*a*) that they are continuous with each other below, or, in other words, that the tendon is simply folded upon itself; (*b*) that the posterior lamina extends to a more proximal level on the humerus than the anterior, and that a fibrous expansion proceeds proximally from its superior border, to seek attachment to the capsule of the shoulder-joint and the lesser tubercle of the humerus; (*c*) that the lower border is connected with the fascia of the arm.

The narrow, thin, flat, band-like tendon of the *latissimus dorsi* lies in front of the insertion of the teres major, but does not extend so far downwards. Therefore the teres major is the lowest muscle in the lateral part of the posterior wall of the axilla, and consequently the last muscle of the posterior axillary wall upon which the axillary artery rests. The slip of fascia which passes from the lower margin of the tendon of the latissimus to the fascia on the long head of the triceps is of interest inasmuch as it represents the dorsi-epitrochlearis muscle of other animals.

Dissection.—Depress the upper border of the subscapularis as it passes below the coracoid process, and expose the subscapular bursa. Inflate the bursa with a blowpipe, and notice that, as air is blown in, the capsule of the shoulder-joint is distended. If the wall of the bursa has been injured in the course of previous dissections, open it with the scalpel and examine the interior with a blunt probe. Note its extent and its continuity with the interior of the shoulder-joint through a large aperture in the anterior part of the articular capsule.

Bursa Subscapularis.—The subscapular bursa is formed by the prolongation of the synovial stratum of the capsule of the shoulder-joint through an aperture in the upper and anterior part of the fibrous stratum. It extends laterally between the subscapularis and the medial part of the articular capsule, medially between the subscapularis and the anterior surface of the neck of the scapula and the root of the coracoid process, and it facilitates the movement of the subscapularis on the front of the head and neck of the scapula.

Dissection.—Cut through the subscapularis vertically below the coracoid process, and detach from its deep surface the bursa, which lies between it and the scapula and the capsule of the shoulder. Turn the medial part of the muscle towards the vertebral border of the scapula, and as you detach it from the bone note the tendinous intersections by which it is connected with the ridges on the costal surface of the scapula. Note also the anastomosis between branches of the subscapular and transverse scapular arteries which ramify on its deep surface. Turn the lateral portion towards the humerus, detaching it from the lateral part of the front of the capsule of the shoulder to which it is adherent, and verify its attachment to the lesser tubercle of the humerus and to the bone immediately distal to the tubercle. Do not fail to notice that, as it crosses the shoulder-joint to its insertion, it lies behind the coraco-brachialis and the short head of the biceps.

Divide the supraspinatus medial to the coracoid process. Turn the medial part towards the vertebral border of the scapula and verify its attachment to the spine and to the dorsal surface of the scapula, and dissect out the branches of the transverse scapular artery and the suprascapular nerve which pass to its deep surface. Turn the lateral part towards the humerus, forcing it beneath the coraco-acromial arch, and as you do that avoid injury to the transverse scapular vessels and the suprascapular nerve which lie beneath it. Note that as the tendon of the muscle crosses the top of the shoulder-joint it is firmly attached to the capsule before it reaches its insertion into the superior facet on the greater tubercle of the humerus. Divide the infraspinatus medial to the lateral border of the spine of the scapula. Verify the attachment of the medial part to the inferior surface of the spine and the dorsal surface of the body of the scapula, dissecting out the vessels and nerves from its deep surface. Follow the lateral part to its insertion into the middle facet on the greater tubercle of the humerus, and, as the muscle is displaced, take care not to injure the transverse scapular vessels, the suprascapular nerve, and the circumflex scapular vessels which lie between it and the bone. Occasionally there is a small bursa between it and the posterior surface of the capsule of the shoulder-joint which communicates with the cavity of the joint.

Divide the teres minor where the circumflex scapular artery passes between it and the posterior surface of the axillary border of the scapula, and verify its origin from the scapula and its insertion into the inferior facet on the greater tubercle of the humerus, and to the ridge which descends from the tubercle.

When the infraspinatus and teres minor have been reflected, look for the *inferior transverse ligament of the scapula.* It is a band of fascia which passes from the lateral border of the spine of the scapula to the posterior border of the glenoid fossa, arching across the great scapular notch. It protects the infraspinous branch of the transverse scapular artery and the suprascapular nerve as they pass behind the neck of the scapula from the supra- to the infraspinous fossa.

Now clean the transverse scapular vessels, and the suprascapular nerve and the circumflex scapulæ branch of the subscapular artery. Commence with the transverse scapular artery as it lies medial to the coracoid process, and the suprascapular nerve which accompanies it. The artery lies on the *superior transverse ligament* of the scapula, immediately medial to the coracoid process. The nerve passes through the notch on the superior border of the scapula beneath the ligament. Follow the artery and nerve behind the neck of the scapula into the infraspinous fossa, and note that both pass between the neck of the scapula and the inferior transverse ligament. Then clean the circumflex scapular artery, and study the transverse ligaments of the scapula and the arterial anastomosis round the scapula.

Ligamenta Transversa Scapulæ.—There are two transverse scapular ligaments—(1) a superior, *ligamentum transversum scapulæ superius*; (2) an inferior, *ligamentum transversum scapulæ inferius* (O.T. *spino-glenoid*). Both the transverse ligaments are associated with the transverse scapular vessels and the suprascapular nerve. The superior transverse ligament bridges across the notch in the superior border of the scapula and converts it into a foramen. It lies between the transverse scapular artery, which passes above it, and the suprascapular nerve, which lies in the notch below it. In not a few cases it is ossified. The inferior transverse ligament is a weaker band which bridges across the great scapular notch at the back of the neck of the scapula, passing from the lateral border of the spine of the scapula to the posterior margin of the glenoid cavity. The infraspinous branch of the transverse scapular artery and the suprascapular nerve lie in the notch, deep to the ligament.

Dissection.—Revise the arteries which lie in relation with the borders and surfaces of the scapula, and dissect out the anastomosis between their branches. Descending along the vertebral border is the descending branch of the transverse cervical artery. Crossing the superior border is the suprascapular artery. The subscapular artery was seen during the dissection of the axilla; it springs from the third part of the axillary, descends for about 25-30 mm. along the inferior border of the subscapularis, and then divides into circumflex scapular and thoraco-dorsal branches. The circumflex scapular at once turns round the axillary border of the scapula and passes, deep to the teres minor, to the infraspinous fossa. Follow the ramifications of both branches to their anastomoses with the adjacent arteries.

The Anastomosis around the Scapula.—An important and free anastomosis takes place between the branches of three arteries which lie in close relation with the scapula, viz.: (1) the descending branch of the transverse cervical artery; (2) the transverse scapular artery; (3) the circumflex scapulæ and thoraco-dorsal branches of the subscapular artery.

The Descending Branch of the Transverse Cervical Artery was seen when the levator scapulæ and the rhomboids were reflected. It runs downwards along the vertebral border of the scapula in the angle between the levator scapulæ and the rhomboids, which are behind it, and the insertion of the serratus anterior, which is in front of it. It sends branches into the subscapular fossa and into the supra- and infraspinous fossæ, which anastomose in all three regions with branches of the transverse scapular and subscapular arteries, and at the inferior angle of the scapula it anastomoses with the terminal branches of the thoraco-dorsal branch of the subscapular artery.

Arteria Transversa Scapulæ (O.T. **Suprascapular Artery**).—The transverse scapular artery enters the supraspinous fossa by passing over the ligament which bridges across the scapular notch. It divides, under cover of the supraspinatus muscle, into a *supraspinous* and an *infraspinous branch*. The former supplies the supraspinatus muscle, and gives off the chief nutrient artery to the scapula; the latter proceeds downwards through the great scapular notch, under cover of the inferior transverse scapular ligament, to reach the deep surface of the infraspinatus muscle, to which it is distributed.

At the superior border of the scapula the transverse artery of the scapula gives off a *subscapular branch*, which enters the subscapular fossa, under cover of the subscapularis muscle.

Arteria Circumflexa Scapulæ (O.T. **Dorsalis Scapulæ Artery**).—The circumflex scapular artery, as already noted, arises from the subscapular branch of the axillary and enters the triangular space. While there it supplies one or two *ventral branches*, which pass, under cover of the subscapular muscle, to the subscapular fossa, and a larger *infrascapular branch*, which runs downwards, in the interval between the teres major and teres minor, to the inferior angle of the scapula (Figs. 34, 35, pp. 79, 80). After those branches are given off, the circumflex scapular artery leaves the triangular space by turning round the axillary border of the scapula, under cover of the teres minor. It now enters the infraspinous fossa, where it ramifies, and supplies branches to the infraspinatus muscle.

Arteria Thoracodorsalis.—The thoraco-dorsal branch of the subscapular artery runs along the axillary border of the scapula on the lower margin of the subscapularis. It sends branches into the subscapular fossa which supply the subscapularis and anastomose with branches of the descending branch of the transverse cervical artery, and the transverse scapular and circumflex scapulæ arteries.

When the dissector has followed the branches of the four arteries just considered, he will realise that the arterial anastomosis around the scapula is very complete. In the supraspinous fossa branches of the descending branch of the transverse cervical artery and the transverse scapular artery anastomose. In the infraspinous fossa branches of the descending branch of the transverse cervical, the transverse scapular, and the subscapular artery anastomose, and branches of the same three arteries anastomose in the subscapular fossa. The importance of these free communications is manifest when it is remembered that two of the main arteries, viz., the descending branch of the transverse cervical artery and the transverse artery of the scapula, spring indirectly from the first part of the subclavian; whilst the third, viz., the subscapular, arises from the third part of the axillary. When, therefore, a ligature is applied to any part of the great arterial trunk of the upper limb, between the first stage of the subclavian and the third part of the axillary, the anastomosis round the scapula affords ample means of re-establishing the circulation.

Nervus Suprascapularis. — The suprascapular nerve accompanies the transverse artery of the scapula, but it enters the supraspinous fossa by passing through the scapular notch, under cover of the upper transverse ligament of the scapula. It supplies the supraspinatus, and ends in the infraspinatus muscle. It usually sends *two articular twigs* to the posterior aspect of the shoulder-joint, viz., one while in the supraspinous fossa and the second as it lies in the infraspinous fossa.

The ligaments which connect the clavicle with the scapula should now be examined; they are (1) the coraco-clavicular ligament, which is found between the clavicle and the coracoid process of the scapula and the capsule of the acromio-clavicular joint.

> ***Dissection.***—Clean the surfaces and borders of the coraco-clavicular ligament, and note that it consists of two segments—a medial segment called the *conoid ligament* and a lateral segment called the *trapezoid ligament*. The two segments meet at an angle which is open in front, and in the angle a small bursa is sometimes found. After the coraco-clavicular ligament has been fully defined, remove the remains of the deltoid and trapezius muscles from the capsule of the acromio-clavicular joint and clean the external surface of the capsule.

Lig. Coracoclaviculare.—The coraco-clavicular ligament is a powerful ligament which binds the inferior surface of the clavicle to the coracoid process. It consists of two parts, which are termed the conoid and the trapezoid ligaments.

The *ligamentum conoideum* lies posterior and medial to the lig. trapezoideum. It is broad above, where it is attached to the coracoid tubercle of the clavicle (Fig. 10, p. 21), and somewhat narrower below, at its attachment to the bend of the coracoid process. The *ligamentum trapezoideum* is a flatter band. Above, it is attached along the trapezoid line of the clavicle (Fig. 10, p. 21), whilst below it is fixed to the upper aspect of the coracoid process.

The coraco-clavicular ligament helps to prevent dislocation of the acromial end of the clavicle, and, to a certain extent, it limits the movements of the acromio-clavicular joint. It is therefore an accessory ligament of that joint. It is the main medium by which the scapula, and, indirectly, the other parts of the superior extremity, are suspended from the clavicle. If it is cut when the body is erect, the superior extremity as a whole at once falls, and the same thing occurs if the clavicle is broken medial to the attachment of the ligament.

Articulatio Acromio-Clavicularis.—The acromio-clavicular joint is a diarthrodial joint; and the ligaments which bind the bones together at the joint are:

Articular Capsule:
  Superior acromio-clavicular ligament.
  Inferior acromio-clavicular ligament.
Accessory Ligament, not connected with the capsule:
  Coraco-clavicular.

The superior and inferior acromio-clavicular ligaments are simply thickened parts of the fibrous stratum of the articular capsule.

The *superior acromio-clavicular ligament* is a broad band, composed of stout fibres, which is placed on the upper aspect of the joint. The *inferior acromio-clavicular ligament*, which closes the joint below, is not so strongly developed. In front and behind, the two ligaments are connected with each other so as to constitute a capsule. The joint should now be opened to display the synovial stratum of the capsule and an imperfect articular disc which is usually present. The disc is wedge-shaped, and connected by its base to the superior ligament, whilst its free margin is directed downwards between the bones.

The two surfaces of the joint are flat and are ovoid in outline, and each slopes obliquely downwards and medially. There is therefore a tendency for the clavicle to glide, upwards and laterally, on to the upper surface of the acromion. The tendency is counteracted by the strength of the superior acromio-clavicular ligament.

THE FRONT OF THE ARM.

In the anterior region of the arm the following structures have to be studied:—

Cutaneous veins.
Cutaneous nerves of the arm.
Parts of the cutaneous nerves of the forearm.
The brachial fascia.

The brachial artery and its branches.

The median, ulnar, radial and musculo-cutaneous nerves.

The biceps, coraco-brachialis and brachialis muscles.

It is convenient to study at the same time the cubital fossa in front of the elbow.

The skin has already been removed, and the cutaneous veins and nerves have been seen (see pp. 62, 63). Now they must be re-studied, and the main points of the surface anatomy of the region must be revised.

Surface Anatomy.—In a muscular limb the prominence formed by the biceps muscle along the front of the arm is very apparent. Every one is familiar with the rounded swelling which the muscle produces when powerfully contracted in the living subject. On each side of the biceps there is a feebly marked furrow, and ascending in each of these there is a large superficial vein. In the lateral sulcus is the cephalic vein; in the distal part of the medial sulcus is the basilic vein. In the proximal part of the medial bicipital sulcus is an elongated bulging produced by the subjacent coraco-brachialis muscle; it is useful as a guide to the distal part of the axillary and the proximal part of the brachial arteries, which lie immediately behind and to the medial side of it. The humerus is thickly clothed by muscles; but towards its distal part the two epicondylar ridges, leading to the epicondylar eminences, may be felt. The lateral ridge is the more salient of the two, and therefore the more evident to touch.

The bony points around the elbow must be studied with especial care. It is by a proper knowledge of the normal relative positions of them that the surgeon is able to distinguish between the different forms of fracture and dislocation which so frequently occur in the elbow region. First note the medial epicondyle of the humerus. It constitutes a prominence appreciable to the eye; grasp it between the finger and thumb, and note that it inclines posteriorly as well as medially. In a well-developed, fully extended arm, the lateral epicondyle does not form a projection on the surface, but can be felt at the bottom of a slight depression on the dorsal aspect of the limb. It becomes apparent to the eye as a prominence when the elbow is semi-flexed. The olecranon produces a marked projection on the dorsum of the elbow between the two epicondyles. It is placed slightly nearer to the medial than to the lateral epicondyle. The loose skin which covers the olecranon moves freely over its subcutaneous surface, owing to the interposition of a bursa. The different positions which are assumed by the olecranon, in relation to the epicondyles of the humerus in the movements of the forearm at the elbow-joint, must be carefully examined. That can be done best by placing the thumb on one epicondyle, the middle finger on the other, and the fore-

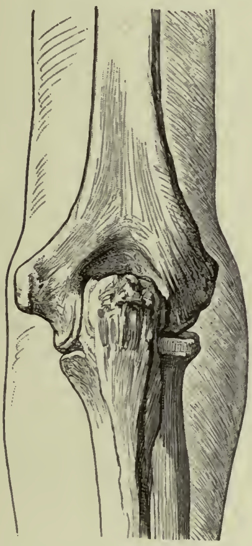


FIG. 39.—Relation of Bones of Elbow to the surface. Dorsal view; elbow fully extended.

FIG. 40. — Relation of the Bones of the Elbow to the surface. Dorsal view; elbow bent.

finger on the olecranon. The limb should then be alternately flexed and extended, so as to make clear the extent of the excursion performed by the olecranon. In full extension at the elbow-joint the three prominences lie in the same horizontal plane; when the forearm is bent at a right angle the three bony points are placed at the angles of an equilateral triangle, of which one angle points distally.

When the forearm is extended a marked depression on the dorsal aspect of the elbow indicates the position of the articulation between the radius and the humerus. Immediately distal to it the head of the radius lies near to the surface, and can readily be felt, especially when it is made to roll under the finger by inducing alternately the movements of pronation and supination. The head of the radius is placed about 25 mm. (one inch) distal to the lateral epicondyle.

Venæ Superficiales.—Portions of two large cutaneous veins are met with in the arm, the cephalic vein and the basilic vein. They were dissected and studied when the cutaneous nerves of the superior extremity were examined (see p. 63). Their positions in the arm should now be revised. Both ascend from the back of the hand, and they communicate with one another across the fascial roof of the cubital fossa at the front of the elbow, by means of the median cubital vein.

In the arm the *cephalic vein* ascends along the groove at the lateral border of the biceps or along the lateral part of the eminence caused by the biceps muscle, to the delto-pectoral sulcus. There it pierces the deep fascia, and it continues upwards to the delto-pectoral triangle where it turns medially, crosses superficial to the pectoralis minor, pierces the costo-coracoid membrane, under cover of the pectoralis major, and terminates in the axillary vein.

The portion of the *basilic vein* which lies in the arm ascends in the groove along the medial border of the biceps muscle. At the middle of the arm it pierces the deep fascia, and runs along the medial side of the brachial artery to the axilla, where it becomes the axillary vein.

Nervi Cutanei.—The cutaneous nerves found in the region of the arm at a previous stage of the dissection were :—

Nn. supraclaviculares (the posterior group) from the cervical plexus.
N. cutaneus brachii lateralis from the axillary nerve.
N. intercosto-brachialis from the second intercostal nerve.
N. cutaneus brachii medialis from the brachial plexus.
N. cutaneus antibrachii medialis from the brachial plexus.
N. cutaneus brachii posterior from the radial nerve.
N. cutaneus antibrachii dorsalis from the radial nerve.
N. cutaneus antibrachii lateralis from the musculo-cutaneous nerve.

All these nerves have already been studied (p. 69); the supraclavicular nerves were removed, and the lateral brachial cutaneous nerve was displaced when the shoulder region was examined. Their general positions and distribution of the remaining nerves should now be revised.

The *intercosto-brachial nerve* supplies the skin of the posterior part of the medial aspect of the arm and the adjacent part of the back of the arm from the axilla to the elbow (Figs. 31, 32).

The *medial cutaneous nerve of the arm* pierces the deep fascia at the middle of the arm, on the medial side, and supplies the skin of the distal half of the medial aspect of the arm. Before it pierces the fascia it gives off no branches of distribution, but it may communicate with the intercosto-brachial nerve (Figs. 31, 16).

The *medial cutaneous nerve of the forearm* pierces the deep fascia at the middle of the arm, on the medial side, sometimes passing through the opening which admits the basilic vein. Before it becomes superficial it gives off several branches which pierce the deep fascia at varying points from the axilla to the middle of the arm; those branches, together with others given off after the nerve pierces the deep fascia, supply the skin on the medial part of the anterior aspect and the anterior part of the medial aspect of the arm, from the axilla to the elbow. The two terminal branches of the nerve, *volar and ulnar*, supply the skin of the medial part of the volar aspect, and the ulnar border of the forearm as far as the wrist. As the volar branch leaves the arm it usually passes between the median cubital vein and the lacertus fibrosus. The ulnar branch descends either in front of or behind the medial epicondyle (Figs. 31, 32).

The *posterior brachial cutaneous nerve* supplies the skin of the middle of the back of the arm from the axilla to the elbow.

The *dorsal cutaneous nerve of the forearm* usually pierces the deep fascia in two parts, a short distance distal to the insertion of the deltoid. The proximal branch supplies some twigs to the lateral part of the back of the arm, and then turns forwards to supply the skin of the lateral part of the front of the arm, from the level of the insertion of the deltoid to the elbow. The distal branch supplies twigs to the distal part of the arm, both on the anterior and posterior aspects, and then descends to supply the skin of the middle of the back of the forearm as far as the wrist (Figs. 31, 32).

The *lateral cutaneous nerve of the forearm* pierces the deep fascia proximal to the elbow, passes deep to the cephalic vein, and supplies the skin on the lateral parts of the volar and dorsal aspects of the forearm as far as the wrist. It also supplies the skin of the proximal part of the thenar eminence (Figs. 31, 32).

Fascia Brachii.—After the cutaneous nerves have been revised re-examine the deep fascia of the arm. Note—(1) that it consists largely of transverse fibres; (2) its close attachment to the bony prominences at the elbow and to the distal parts of the medial and lateral borders of the humerus; (3) its connection with the muscles which spring from the medial and lateral epicondyles of the humerus; (4) the thickened band of fibres called the *lacertus fibrosus* which passes from the distal part of the medial border of the biceps to the medial side of the proximal part of the forearm (Figs. 31, 61). It is also connected with the tendons of insertion of the deltoid, the pectoralis major and the latissimus dorsi, but those connections were severed when the muscles were cleaned.

Dissection.—(1) Cut through the deep fascia along the proximal and distal borders of the lacertus fibrosus, from the medial margin of the biceps to the medial margin of the forearm, and leave the lacertus fibrosus in position when the remainder of the deep fascia is reflected. (2) Make a longitudinal incision through the deep fascia along the middle line of the biceps. (3) At the level of the epicondyles make a transverse incision through each of the flaps marked out by the longitudinal incision, and (4) reflect each of the two flaps to its own side. As the reflection proceeds it will become evident that septa pass from the deep surface of the deep fascia between the various muscles. Thus a septum passes transversely from side to side between the biceps and brachialis muscles (Figs. 42, 43). In it is embedded the musculo-cutaneous nerve. A septum dips backwards between the brachialis and the muscles which spring from the anterior lip of the distal half of the lateral border of the humerus. The radial nerve and anterior branch of the profunda artery are embedded in it (Fig. 42), but the strongest and most important septa are the lateral and medial intermuscular septa which separate the structures at the back of the arm from those at the front. Each is attached to the whole length of the corresponding border of the body of the humerus, but the distal halves are the strongest parts. The medial inter-

muscular septum is stronger than the lateral. It is easily traced from the medial epicondyle to the insertion of the coraco-brachialis muscle. The distal half of the lateral intermuscular septum is quite definite from the lateral epicondyle to the insertion of the deltoid muscle. The two septa, together with the humerus, divide the arm into an anterior and a posterior osteo-fascial compartment.

Structures in the Anterior Compartment.—The anterior osteo-fascial compartment has been opened by the reflection of the anterior part of the deep fascia; the relative positions of its contents must now be examined. The contents are: Three muscles which belong mainly to the arm, the biceps,

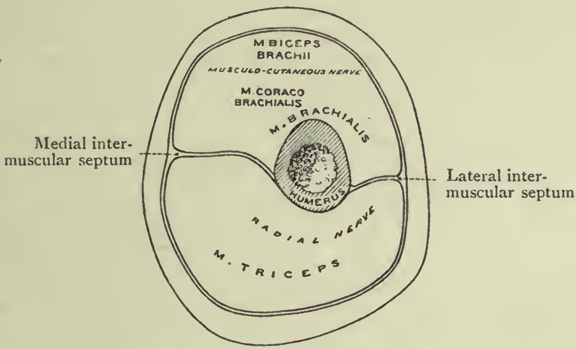


FIG. 41.—Diagram (after Turner) to show how the Arm is divided by the intermuscular septa and the bone into an anterior and a posterior compartment. These compartments are represented in transverse section.

the coraco-brachialis, and the brachialis; parts of two muscles which belong chiefly to the forearm—the brachio-radialis and the extensor carpi radialis longus; parts of the terminal branches of all the cords of the brachial plexus except the axillary nerve; the brachial artery, its venæ comites, part of the basilic vein, with accompanying lymph vessels and a few small brachial lymph glands which lie along the course of the brachial artery.

The biceps brachii is the most anterior muscle; under cover of its distal half and closely applied to the anterior aspect of the humerus is the brachialis, whilst the slender coraco-brachialis lies along the medial side of the proximal half of the biceps. The brachio-radialis and the extensor carpi radialis longus lie in the distal part of the compartment along the lateral side of the brachialis, to which they are closely applied. The brachial artery and its venæ comites traverse the whole length of the compartment in relation with the medial border of the biceps. The median nerve also runs through the whole length of the compartment lying, in the proximal half, lateral to the brachial artery, and in the distal half, medial to it. The basilic vein enters the compartment at the middle of the arm, where it pierces the deep fascia, and then ascends along the medial side of the brachial artery.

Dissection.—If the piece of wood, to which the axillary artery and the nerves were previously fixed, has been detached from the coracoid process, retie it to that process and proceed to clean the brachial artery and its branches, its venae comites, the deep proximal part of the basilic vein, and the accompanying nerves. It is important that the artery should be disturbed as little as possible before its relations are studied. Therefore commence the dissection by cleaning the nerves and the veins, and take care not to injure the branches of the artery. Begin with the medial cutaneous nerve of the arm, trace it along the medial side of the basilic vein and through the opening in the deep fascia to its termination. As a rule it gives off no branches of distribution before it pierces the deep fascia, but it communicates with the intercosto-brachial nerve (Fig. 16). Next follow the median cutaneous nerve of the forearm along the groove between the anterior border of the basilic vein and the brachial artery, and through the opening in the deep fascia to the bend of the elbow. It gives off several branches before it pierces the deep fascia (p. 69). Now clean the basilic vein, displace it forwards and follow the ulnar nerve, which descends, along the posterior angle between the brachial artery and the basilic vein, to the middle of the arm. Then, at the level of the insertion of the coraco-brachialis, it passes backwards, accompanied by the superior ulnar collateral branch of the brachial artery, pierces the medial intermuscular septum, and enters the posterior compartment of the arm, where it will be dissected at a later period. The median nerve should next be cleaned. Follow it along the lateral margin of the proximal part of the brachial artery to the middle of the arm, there it crosses anterior to the artery and then descends, on its medial side, to the cubital fossa ; note that the nerve gives off no branches till the cubital fossa is reached. After the median nerve has been cleaned, clean the venæ comites of the artery. Note that they anastomose across the artery frequently, and that at the lower border of the subscapularis they end in the axillary vein. Now displace the proximal part of the brachial artery forwards and follow the radial (*musculo-spiral*) nerve behind it, to the proximal end of the sulcus for the radial nerve at the back of the humerus. The radial nerve is accompanied by the profunda branch of the brachial artery. Clean the branches which pass from the lateral side of the artery to the biceps,

coraco-brachialis, and brachialis. A little distal to the middle of the arm, on the medial side of the artery, seek for its nutrient branch to the humerus. Clean the superior profunda branch, which accompanies the radial nerve, and the superior ulnar collateral branch which accompanies the ulnar nerve. About two inches proximal to the elbow, find the inferior ulnar collateral branch, follow it towards the medial intermuscular septum, and note its division into two branches, an anterior which descends in the front of the medial epicondyle to anastomose with the volar ulnar recurrent, and a posterior which pierces the medial intermuscular septum. Lastly, clean the brachial artery itself.

Nervus Medianus.—The median nerve arises in the axilla by two heads, one from the medial and one from the lateral cord of the brachial plexus. The medial head crosses the front of the axillary artery to unite with the lateral head. The nerve thus formed descends, along the lateral side of the distal part of the axillary artery and the proximal half of the brachial artery, to the level of the insertion of the coraco-brachialis; there it crosses in front of the brachial artery (sometimes behind) and descends along its medial side to the bend of the elbow. It gives off no branches either in the axilla or in the arm.

Nervus Ulnaris.—The ulnar nerve is the largest branch of the medial cord of the brachial plexus. It descends, along the medial sides of the third part of the axillary artery and of the proximal half of the brachial artery, to the insertion of the coraco-brachialis; then it leaves the brachial artery and, accompanied by the superior ulnar collateral artery, passes distally and backwards through the medial intermuscular septum, into the posterior compartment. In the posterior compartment it descends, along the medial head of the triceps, to the back of the medial epicondyle. Do not follow it into the posterior compartment at present; it will be dissected there at a later period. Like the median nerve it gives off no branches whilst it is in the axilla and the arm. Accompanying the ulnar nerve will be found the ulnar collateral branch of the radial nerve which descends to the distal part of the medial head of the triceps.

Arteria Brachialis.—The brachial artery is the direct continuation of the axillary artery; it begins, therefore, at the lower border of the teres major, and it passes, distally and slightly laterally, to the cubital fossa, where, at the level of the neck of the radius, it divides into its two terminal branches—the radial and the ulnar arteries. In the proximal part of the arm it lies to the medial side of the humerus, but as it approaches the elbow it passes to the front of the humerus.

This change of position must be borne in mind when pressure is applied to the vessel with the view of controlling the flow of blood through it. In the proximal part of the arm the pressure must be directed laterally and backwards, and in the distal part directly backwards.

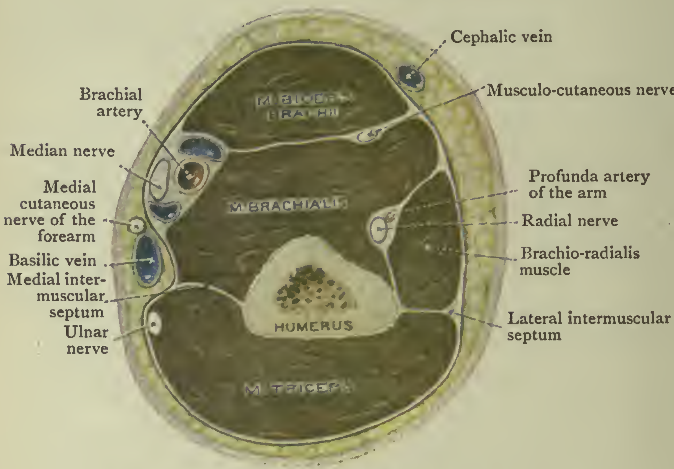


FIG. 42.—Transverse section through the Distal Third of the Right Arm.

Relations.—The brachial artery is superficial in the whole of its length. To expose it, therefore, it is necessary to reflect only the skin and the fascia; but it is overlapped, from the lateral side, by the medial margins of the coraco-brachialis and biceps brachii (see Figs. 10, 41). At the bend of the elbow it is crossed superficially by the lacertus fibrosus, which intervenes between it and the median cubital vein.

The basilic vein lies to the medial side of the artery and on a somewhat posterior plane. In the distal part of the arm it is separated from the artery by the deep fascia; but in the proximal part, after the vein has pierced the fascia, it comes into closer relationship with the artery. The two venæ comites are closely applied to the sides of the artery, and the numerous connecting branches which pass between them, both in front of and behind the artery, make the relationship still more intimate.

Behind the brachial artery there are four muscles. Proximo-distally, they are—(1) the long head of the triceps, which is separated from the artery by the radial nerve and the profunda vessels; (2) the medial head of the triceps; (3) the insertion of the coraco-brachialis; (4) in the remainder of its course the brachialis forms the posterior relation.

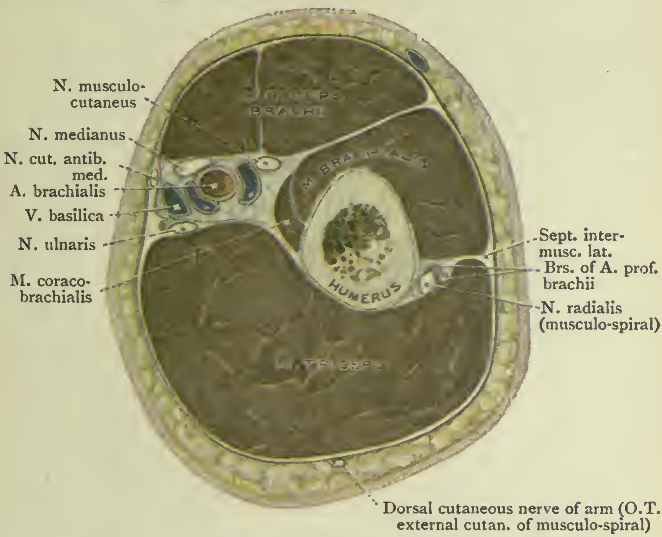


FIG. 43.—Transverse section through Middle of the Arm.

With the exception of the musculo-cutaneous nerve, all the terminal branches of the brachial plexus lie in relation to the brachial artery. The median nerve lies on the lateral side and somewhat anteriorly in the proximal half of the arm; it crosses anterior to the artery at the level of the insertion of the coraco-brachialis, and in the distal half of the arm and in the cubital fossa it is to the medial side of the artery. The ulnar nerve and the medial cutaneous nerve of the forearm lie close to the medial side of the artery as far as the insertion of the coraco-brachialis; then they leave it. The ulnar nerve inclines backwards, pierces the medial intermuscular septum, and, passing behind the medial epicondyle, enters the forearm. The medial cutaneous nerve of the forearm inclines forwards and medially, pierces the fascia brachii and becomes superficial. The radial nerve is behind the proximal part of the artery, but it soon leaves it by passing distally and laterally into the sulcus for the radial nerve, between the medial and the lateral heads of the triceps.

Branches of the Brachial Artery.—Several branches arise from the brachial artery. Those which arise from its lateral aspect are irregular in number, origin, and size. They are termed the *lateral branches*, and are distributed to the muscles and integument on the front of the arm. The series of *medial branches* which proceed from the medial and posterior aspect of the parent trunk are named as follows as they arise proximo-distally :—

1. A. profunda brachii.
2. A. collateralis ulnaris superior.
3. A. nutricia humeri.
4. A. collateralis ulnaris inferior.

The *profunda artery* (O.T. superior profunda) is the largest of the branches which spring from the brachial trunk. It takes origin about 25 mm. (one inch) or so distal to the lower margin of the teres major, and associates itself with the radial (musculo-spiral) nerve, which it accompanies to the back of the arm. Consequently, only a short part of the vessel is seen in the present dissection. It soon disappears from view between the long and medial heads of the triceps.

The *superior ulnar collateral artery* (O.T. inferior profunda) is a long slender artery, which can be recognised from the fact that it follows closely the course pursued by the ulnar nerve. Its origin is somewhat variable. As a general rule, it issues from the brachial artery opposite the insertion of the coraco-brachialis, but very frequently it arises in common with the profunda brachii. It pierces the medial intermuscular septum, with the ulnar nerve, and descends behind that fascial partition to the interval between the olecranon and the medial epicondyle of the humerus.

The *nutrient artery* may arise directly from the brachial trunk, or take origin from the superior ulnar collateral artery. It should be sought for at the distal border of the insertion of the coraco-brachialis, and the dissector should not be satisfied until he has traced it into the nutrient foramen of the bone. When the nutrient artery is not seen in its usual position it will probably be found in the dissection of the back of the arm, taking origin from the profunda artery.

The *inferior ulnar collateral artery* (O.T. anastomotica)

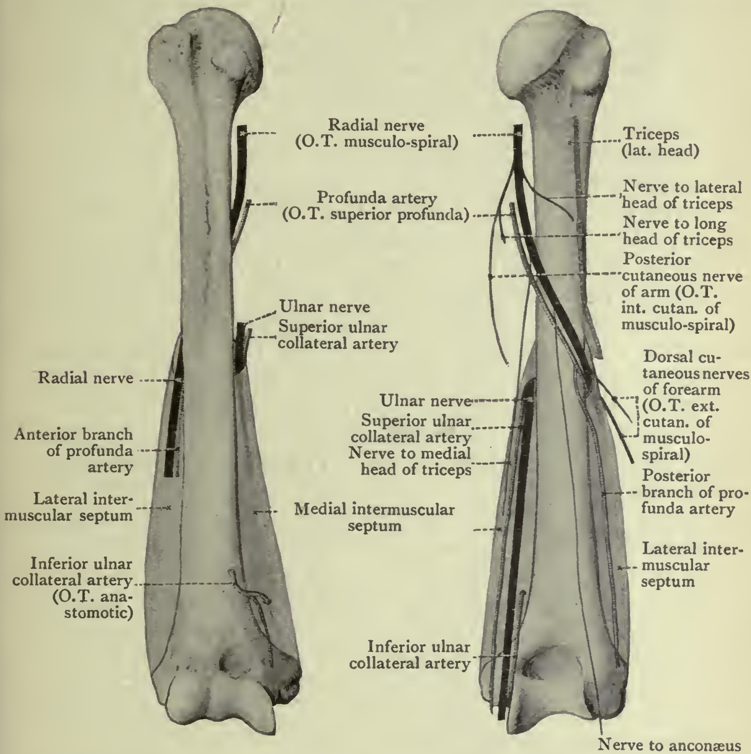


FIG. 44.—Diagram to show relation of Radial Nerve (O.T. Musculo-spiral) to the Humerus, and of Vessels and Nerves to the Intermuscular Septa.

arises about 50 mm. (two inches) proximal to the bend of the elbow, and runs medially upon the brachialis. It soon divides into a small anterior and a larger posterior branch. The *anterior branch* is carried distally in front of the medial epicondyle of the humerus, in the interval between the brachialis and the pronator teres. It anastomoses with the volar ulnar recurrent artery. The *posterior branch* pierces the medial intermuscular septum, and will be seen, at a later stage, in the posterior compartment of the arm.

Dissection.—**Clean the biceps brachii. Clean the coraco-brachialis; separate it carefully from the short head of the biceps, and find the musculo-cutaneous nerve as it leaves the lateral surface of the coraco-brachialis. Follow the musculo-cutaneous nerve, between the biceps and the brachialis, to the point where it emerges at the lateral border of the tendon of the biceps and becomes the lateral cutaneous nerve of the forearm. Clean the brachialis as far as the bend of the elbow, but do not injure the lacertus fibrosus.**

Nervus Musculocutaneus.—The musculo-cutaneous nerve arises from the lateral cord of the brachial plexus, at the lower border of the pectoralis minor. Inclining laterally, it perforates the coraco-brachialis, and passes between the biceps brachii and the brachialis. It proceeds obliquely distally, between those muscles, until it reaches the bend of the elbow, where it comes to the surface at the lateral border of the tendon of the biceps brachii. From that point onwards it has already been traced as the lateral cutaneous nerve of the forearm (p. 69).

In the arm the musculo-cutaneous nerve supplies branches to three muscles of the region. The branch to the coraco-brachialis is given off before the parent trunk enters the substance of the muscle; the branches to the biceps brachii and brachialis issue from it as it lies between them.

M. Coracobrachialis.—The coraco-brachialis is an elongated muscle, which takes origin from the tip of the coracoid process, in conjunction with the short head of the biceps brachii. It proceeds distally, along the medial margin of the biceps brachii, and obtains insertion into a linear ridge situated upon the medial aspect of the body of the humerus, about its middle.

M. Biceps Brachii.—The biceps brachii muscle arises from the scapula by two distinct heads of origin. The *short* or *medial head* springs from the tip of the coracoid process in conjunction with the coraco-brachialis (Fig. 24, p. 46). The *long* or *lateral head* is a rounded tendon, which occupies the intertubercular sulcus of the humerus. Its origin cannot be studied at this stage of the dissection, because it is placed within the capsule of the shoulder-joint, where it arises from an impression on the scapula immediately above the glenoid cavity.

Both heads swell out into elongated fleshy bellies, which, at first, are merely closely applied to each other, but afterwards are united in the distal third of the arm. Towards the bend of the elbow the fleshy fibres converge upon a stout, short tendon, which is inserted into the dorsal part of the tuberosity of the radius. The insertion will be more fully examined at a later period, but it may be noticed, in the meantime, that the tendon is twisted so as to present its margins to the front and dorsal aspect of the limb, and, further, that a bursa mucosa is interposed between it and the smooth, volar part of the radial tuberosity.

The dissector has already taken notice of the *lacertus fibrosus*, and has separated it, artificially, from the deep fascia of the arm, and of the forearm. Observe now that it springs from the anterior margin of the tendon of the biceps brachii, and also from the short head of the muscle. It is supplied by the musculo-cutaneous nerve and is a supinator of the forearm and a flexor of the elbow-joint.

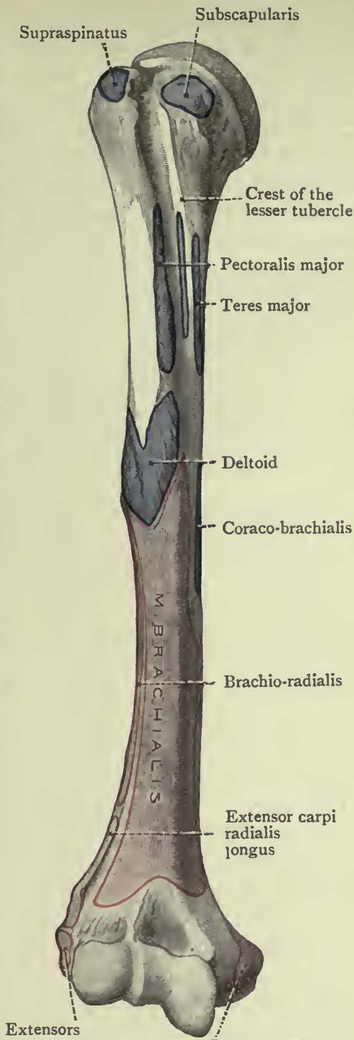


FIG. 45.—Anterior aspect of Humerus with Muscular Attachments mapped out.

M. Brachialis (O.T.

Brachialis Anticus).—The brachialis arises from the entire width of the anterior aspect of the distal half of the body of the humerus, from the medial intermuscular septum, and from a small part of the lateral intermuscular septum proximal to the brachio-radialis. The origin from the bone is prolonged proximally in two slips which partially embrace the insertion of the deltoid. The fibres converge to be inserted into the base of the coronoid process of the ulna by a short, thick tendon. The muscle lies partly under cover of the biceps brachii, but projects beyond it on each side. It is overlapped on its medial side by the pronator teres, and on the lateral side by the brachio-radialis and extensor carpi radialis longus. Its deep surface is closely connected to the anterior part of the capsule of the elbow-joint. Its chief nerve of supply, from the *musculo-cutaneous*, has already been secured, but it receives also one or two small twigs from the radial (*musculo-spiral*) nerve which are given off under cover of the brachio-radialis. It is a flexor of the elbow-joint.

***Dissection.*—Separate the brachio-radialis from the brachialis muscle, and dissect out the radial nerve, with the anterior terminal branch of the profunda brachii artery, which lie deeply in the interval between the muscles. There also, in a well-injected subject, the anastomosis between the profunda brachii artery and the radial recurrent artery may be made out; and the twigs which are given by the radial nerve to the brachialis, the brachio-radialis, and the extensor carpi radialis longus, should be looked for.**

Fossa Cubitalis.—The cubital fossa is the hollow in front of the elbow. It is triangular in outline and it corresponds generally with the popliteal fossa at the back of the knee.

It possesses a roof or superficial boundary; a floor or deep boundary; medial and lateral boundaries; a base and an apex.

The roof is formed by the deep fascia in which lies the thickened band called the lacertus fibrosus. It is pierced by a communication from the deep veins of the forearm to the median cubital vein. It is covered by the skin and superficial fascia, and upon it, in the superficial fascia, lie a portion of the cephalic vein, a portion of the basilic vein, the median cubital vein, the volar branch of the medial cutaneous nerve of the forearm, and the lateral cutaneous nerve of the forearm.

The "base" is an imaginary line drawn between the two epicondyles of the humerus. The medial border, formed by the lateral margin of the pronator teres muscle

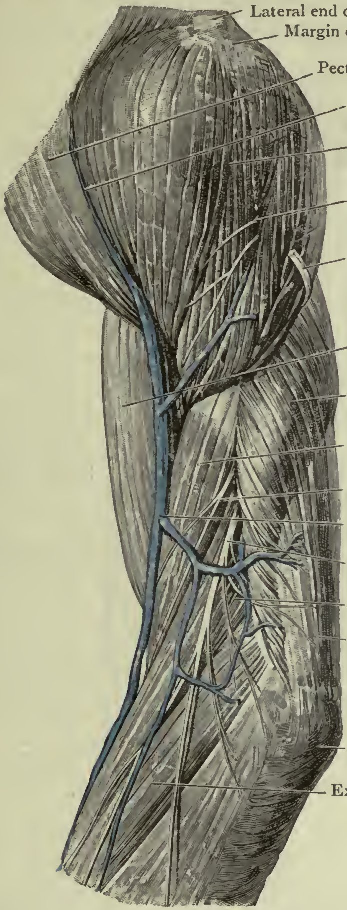


FIG. 46.—The Deltoid Muscle and the lateral aspect of the Arm.

descending from the medial epicondyle, and the lateral border, formed by the medial margin of the brachio-radialis, as it descends from the lateral supra-epicondylar ridge, meet distally at the apex where the brachio-radialis overlaps the pronator teres. The floor is formed by the distal part of the brachialis muscle and the anterior part of the supinator.

Within the fossa are the termination of the brachial artery, and the proximal parts of the radial and ulnar arteries, into which it divides. To the lateral side of the main vessel

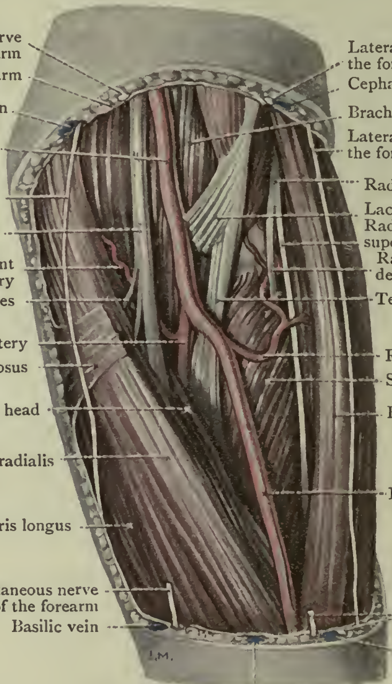


FIG. 47.—Dissection of the Left Cubital Fossa.

is placed the tendon of the biceps brachii, and to its medial side, the median nerve. A quantity of loose fat also is present. The ulnar artery leaves the space by passing under cover of the pronator teres; the radial artery is continued distally beyond the apex of the fossa, overlapped by the brachio-radialis. The median nerve disappears between the two heads of the pronator teres, and the tendon of the biceps brachii inclines posteriorly, between the two bones of the forearm, to reach its insertion into the radial tuberosity.

Other structures which are under cover of the boundaries but are not strictly within the fossa are:—the termination of the radial nerve and parts of its deep and superficial divisions; the anterior terminal branch of the profunda artery; the radial recurrent artery; the volar and dorsal ulnar recurrent arteries and twigs of the superior and inferior ulnar collateral arteries.

Dissection.—The fascial roof of the cubital fossa was partially destroyed when the deep fascia of the front of the arm was reflected, but the lacertus fibrosus is still in position. Now cut across the lacertus near the biceps (Fig. 47), and reflect it towards the medial border of the forearm, then proceed to clean the contents of the fossa. Pull aside the medial and lateral boundaries with hooks and then commence with the median nerve. Follow it from above downwards to the point where it disappears between the two heads of the pronator teres, and secure the branches which spring from its medial side and pass to the muscles which arise from the medial epicondyle of the humerus.

Next clean the brachial artery, also from above downwards. If its venæ comites are in the way remove them. Follow the artery to its division into its radial and ulnar branches, then follow the radial artery to the apex of the fossa, and the ulnar artery to the point where it disappears behind the deep head of the pronator teres. Do not injure the radial recurrent branch which springs from the lateral side of the radial artery, or the volar and dorsal ulnar recurrent branches which arise from the medial side of the ulnar artery. Now clean the tendon of the biceps brachii and follow it to its insertion into the posterior part of the tuberosity of the radius, and note that, as it passes to its insertion, it twists so that its anterior surface becomes lateral, and its posterior surface becomes medial. The tendon is separated from the anterior part of the tuberosity by a small bursa which may be opened with the point of the scalpel.

To facilitate the cleaning of the floor and to expose structures which are not strictly contents of the fossa, but which lie close to it, under cover of its medial and lateral boundaries, flex the elbow slightly, and pull the medial and lateral boundaries of the fossa still wider apart. Find the termination of the radial nerve, and the anterior terminal branch of the profunda artery at the level of the lateral epicondyle between the brachio-radialis and the brachialis. Follow the deep and superficial terminal branches of the nerve, downwards in front of the lateral part of the capsule of the elbow-joint. The deep branch disappears into the substance of the supinator. The superficial division descends between the brachio-radialis and the supinator, either superficial or deep to the branches of the radial recurrent artery. The termination of the superficial division has already been dissected on the dorsum of the hand where it supplies the lateral three-and-a-half digits (see p. 71). Next follow the radial recurrent artery to the lateral epicondyle, where it anastomoses with the anterior terminal branch of the profunda artery. Then trace the volar and dorsal recurrent branches of the ulnar artery to

the medial epicondyle where they anastomose with the superior and inferior ulnar collateral branches of the brachial artery.

After the relative positions of the contents of the cubital fossa have been studied turn to the dissection of the back of the arm.

DORSUM OF THE ARM.

In this region in addition to the cutaneous nerves the following are the structures which must be studied:—

1. The triceps muscle.
2. The profunda brachii artery, and the radial nerve.
3. The superior ulnar collateral artery, and the ulnar nerve.
4. The posterior branch of the inferior ulnar collateral artery.
5. The subanconæus muscle.

The skin and the superficial fascia have already been removed but the cutaneous nerves are still present, and the dissector should revise them before proceeding with the dissection.

On the medial side are branches of the intercosto-brachial nerve; lateral to them lies the posterior brachial cutaneous branch of the radial nerve, and, along the lateral margin of the arm, is the dorsal cutaneous nerve of the forearm, also a branch of the radial nerve.

***Dissection.*—Make a vertical incision through the deep fascia as far as the olecranon of the ulna, and a transverse incision across the olecranon from one epicondyle to the other, taking care not to injure the dorsal cutaneous nerve of the forearm. Reflect the flaps of deep fascia to their respective sides until their continuity with the medial and lateral intermuscular septa respectively is demonstrated. As the medial flap is reflected, avoid injury to the ulnar nerve which descends towards the medial epicondyle on the medial head of the triceps. It is accompanied by the superior ulnar collateral artery. When the reflection of the flaps is completed clean the triceps muscle and define carefully its attachments to the scapula, to the humerus, and to the ulna.**

M. Triceps Brachii.—The triceps muscle occupies the entire posterior osteo-fascial compartment of the arm. It arises by a *long head* from the scapula, and by two shorter heads, *lateral* and *medial*, from the humerus. The fleshy fibres of the three heads join a common tendon, which is inserted into the proximal surface of the olecranon of the ulna. The superficial part of the muscle is, for the most part, formed by the long head and the lateral head of the muscle. The medial head is deeply placed; only a very small portion of it appears superficially, in the distal part of the arm, on each side of the common tendon of insertion.

The *long head* of the triceps arises, by a flattened tendon, from the rough triangular impression on the upper part of the axillary border and the lower aspect of the neck of the scapula in the interval between the teres minor and subscapularis muscles (Fig. 24, p. 46).

The *two humeral heads* take origin from the posterior aspect of the humerus; and if it is borne in mind that no fibres arise from the sulcus for the radial nerve and that the groove intervenes between the origins of the two heads, their relations will be easily understood. The dissector should provide himself with a humerus, and, having first identified the sulcus for the radial nerve, proceed to map out the areas of attachment of the humeral heads of the triceps as they are exhibited in the dissected part.

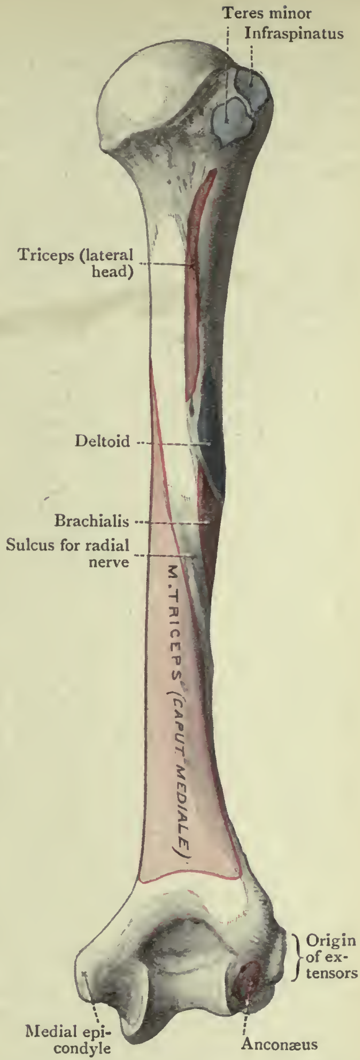


FIG. 48.—Dorsal aspect of the Humerus with Attachments of Muscles mapped out.

The *lateral head* of the triceps arises from the lateral and posterior aspect of the body of the humerus, proximal to the sulcus for the radial nerve. It takes origin, by short tendinous fibres, along a line which passes distally from the insertion of the teres minor to the proximal border of the sulcus for the radial nerve. But it derives fibres also from a strong fascial bridge or arch which is thrown over the groove so as to give protection to the profunda brachii artery and the radial nerve. The strength and position of this arch can be estimated by thrusting the handle of the knife distally and laterally in the sulcus for the radial nerve, and along the course of the nerve and artery, under the lateral head of the triceps. By its distal end the arch is connected with the lateral intermuscular septum.

The *medial head* of the triceps is placed distal to the sulcus for the radial nerve. Its proximal end, which is narrow and pointed, lies close to the distal end of the insertion of the teres major. The origin gradually widens as the sulcus for the radial nerve passes towards the lateral border of the humerus, and in the distal third of the arm it covers the posterior surface of the humerus from the lateral to the medial border (Fig. 48). It springs also from the posterior surface of the medial intermuscular septum, and from the distal part of the corresponding surface of the lateral intermuscular septum. The medial head of the triceps, therefore, has very much the same origin from the posterior surface of the bone that the brachialis has from the anterior aspect.

The dissector should now study the *common tendon of insertion* of the triceps. The long and the lateral heads end in a broad, flat tendon, which is inserted into the back part of the proximal surface of the olecranon, and at the same time gives off, on the lateral side, a strong expansion to the fascia of the forearm as it covers the anconæus muscle. The short fleshy fibres of the medial head are, for the most part, inserted into the deep surface of the common tendon, but a considerable number find direct attachment to the olecranon, whilst a few of the deepest fibres are inserted into the loose posterior part of the capsule of the elbow-joint. The latter fibres have been described as a separate muscle under the name of *subanconæus*. The triceps is supplied by branches from the *radial nerve*. It is an extensor of the elbow-joint and an adductor of the arm.

Dissection.—In order that the radial nerve and the profunda brachii artery may be fully exposed, the lateral head of the triceps must be divided. Thrust the handle of a knife along the sulcus for the radial nerve, and under the muscle. The handle will then give the direction in which the lateral head of the triceps should be severed. Beyond cleaning the nerve and its branches, and the profunda brachii artery, as they lie in the groove, no further dissection is necessary.

Nervus Radialis (O.T. Musculo-Spiral Nerve).—The radial nerve is the direct continuation of the posterior cord of the brachial plexus after it has furnished, in the axilla, the two subscapular nerves, the thoraco-dorsal nerve, and the axillary nerve. In the first instance, the radial nerve proceeds distally, behind the distal part of the axillary artery and the proximal part of the brachial artery. It soon leaves the anterior aspect of the arm, however, and, inclining backwards, with the *profunda brachii artery*, enters the interval between the long and the medial heads of the triceps, and reaches the sulcus for the radial nerve. In that it passes round the back of the body of the humerus, under cover of the lateral head of the triceps, and on the lateral side of the limb it pierces the lateral intermuscular septum and passes into the anterior compartment of the arm, where it has already been dissected. There it lies deeply, in the interval between the brachialis on the medial side and the brachio-radialis and extensor carpi radialis longus on the lateral side, and it ends at the level of the lateral epicondyle of the humerus by dividing into two terminal branches, viz., the ramus superficialis (O.T. radial) and the ramus profundus (O.T. posterior interosseous). The radial nerve presents, therefore, very different relations as it is traced from its origin to its termination: (1) between the subscapularis, latissimus dorsi, teres major, and long head of the triceps, which support it behind, and the axillary and brachial arteries which are placed in front of it; (2) between the long and the medial heads of the triceps; (3) in the sulcus for the radial nerve, between the bone and the lateral head of the triceps; (4) in the interval between the brachialis on the medial side, and the brachio-radialis and extensor carpi radialis longus on the lateral side.

The branches which proceed from the radial nerve are *muscular*, *cutaneous*, *articular* and *terminal.*

The *cutaneous branches* are two in number, and have already been traced. They are—(1) the posterior cutaneous nerve of the arm, and (2) and (3) the dorsal cutaneous nerves of the forearm.

The *muscular branches* are distributed to the three heads

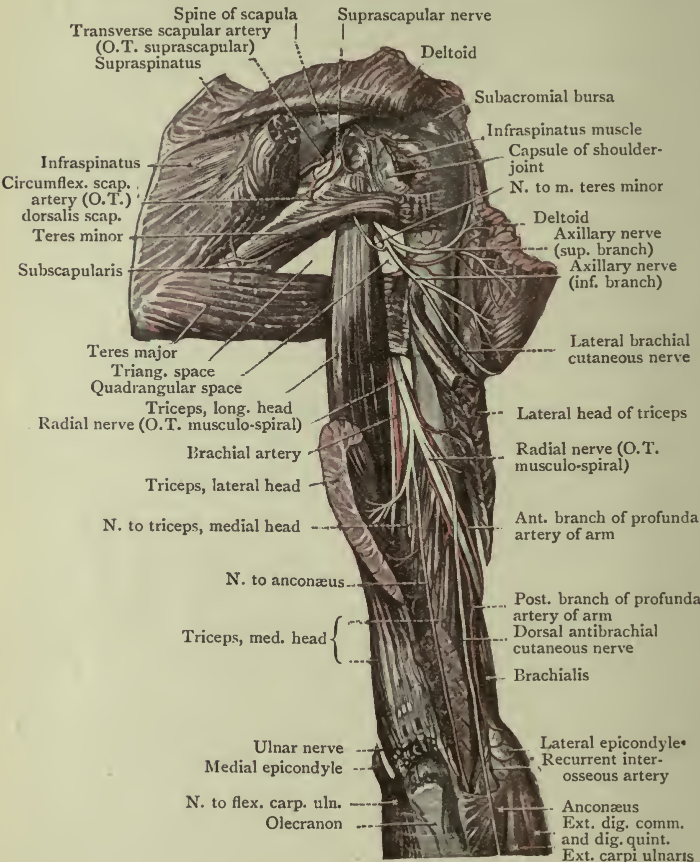


FIG. 49.—Dissection of the dorsal aspect of the Arm. The lateral head of the Triceps has been divided and turned aside to expose the sulcus on the Humerus for the radial nerve.

of the triceps, to the anconæus, to the lateral fibres of the brachialis, to the brachio-radialis, and to the extensor carpi radialis longus. The branches to the three last-named muscles spring from the trunk of the nerve after it has pierced the lateral intermuscular septum. One of the branches to the medial head of the triceps is a long slender nerve, termed the *ulnar collateral nerve*, on account of its association with the ulnar nerve in the arm. The branch to the anconæus is a long slender twig which passes through the substance of the medial head of the triceps on its way to the anconæus (Fig. 49).

The *terminal branches* are the *superficial ramus*, which is a purely cutaneous nerve, and the *deep ramus*, which is continued into the dorsal part of the forearm as the dorsal interosseous nerve, and is distributed to the muscles on the dorsal aspect of the forearm, and to the radio-carpal joint. These nerves will be followed later.

Arteria Profunda Brachii.—The profunda brachii artery has been already seen taking origin from the brachial trunk, about 25 mm. distal to the lower margin of the teres major muscle. It accompanies the radial nerve, and its relations to the three heads of the triceps and the sulcus for the radial nerve are exactly the same as those of the nerve. Before it reaches the lateral intermuscular septum, it ends by dividing into two terminal branches—an anterior and a posterior. The *anterior* and *smaller branch* accompanies the radial nerve through the septum, and follows it distally to the anterior aspect of the lateral epicondyle of the humerus, where it anastomoses with the radial recurrent artery. The *posterior*, *larger branch* descends on the posterior surface of the lateral intermuscular septum, and anastomoses on the back of the lateral epicondyle of the humerus with the interosseous recurrent artery.

The branches which proceed from the *profunda brachii artery* are distributed chiefly to the three heads of the triceps muscle. One twig runs proximally between the long and lateral heads of the muscle, and anastomoses with the *posterior circumflex artery of the humerus*. In that way a link is established between the axillary and brachial systems of branches.

Dissection.—The ulnar nerve, with the superior ulnar collateral artery, and the slender ulnar collateral nerve, can now be satisfactorily followed, as they proceed distally upon the posterior aspect of the medial intermuscular septum. They are covered by a thin layer of fleshy fibres belonging to the medial head of the triceps. The posterior branch of the inferior ulnar collateral artery, after it has pierced the medial septum, should also be dissected out. As a rule, a transverse anastomosing twig passes between that vessel and the posterior terminal part of the profunda brachii artery. It lies upon the posterior aspect of the humerus, immediately proximal to the elbow-joint, and can be exposed by dividing the triceps muscle a short distance proximal to the olecranon. At the same time the fleshy fibres of the medial head of the triceps, which are inserted into the posterior part of the capsule of the elbow-joint, and constitute the *subanconæus muscle*, should be examined. Lastly, raise the distal piece of the triceps from the elbow-joint, and look for a small bursa mucosa between the deep surface of the triceps tendon and the anterior part of the proximal aspect of the olecranon. Then revise the medial and lateral intermuscular septa which are now fully exposed.

The Medial and Lateral Intermuscular Septa.—The medial intermuscular septum is the stronger; it separates the medial part of the medial head of the triceps from the brachialis, gives attachment to both the muscles, and extends, as a strong membrane, from the medial epicondyle to the insertion of the coraco-brachialis. Then it becomes less distinct, but it can be traced proximally to the lower part of the medial lip of the intertubercular sulcus. At the level of the insertion of the coraco-brachialis it is pierced by the ulnar nerve and the superior ulnar collateral artery, which descend posterior to it to the medial epicondyle. A short distance above the medial epicondyle it is pierced by the posterior branch of the inferior ulnar collateral artery.

The lateral intermuscular septum is weaker than the medial. It extends from the lateral epicondyle to the insertion of the deltoid muscle, with which it blends, and it separates the lateral part of the medial head of the triceps, which is attached to its posterior surface, from the upper lateral part of the brachialis, the brachio-radialis and the extensor carpi radialis longus which spring from its anterior surface. At the junction of the middle and distal thirds of the arm it is pierced by the radial nerve and the anterior branch of the profunda artery, which afterwards descend along its anterior aspect, between the brachialis medially and the brachio-radialis and the extensor carpi radialis longus laterally.

ARTICULATIO HUMERI (SHOULDER-JOINT).

After the structures situated in the arm have been examined the dissection of the shoulder-joint should be commenced, in order that the ligaments may be examined before they have become too dry.

The shoulder-joint belongs to the enarthrodial or ball and

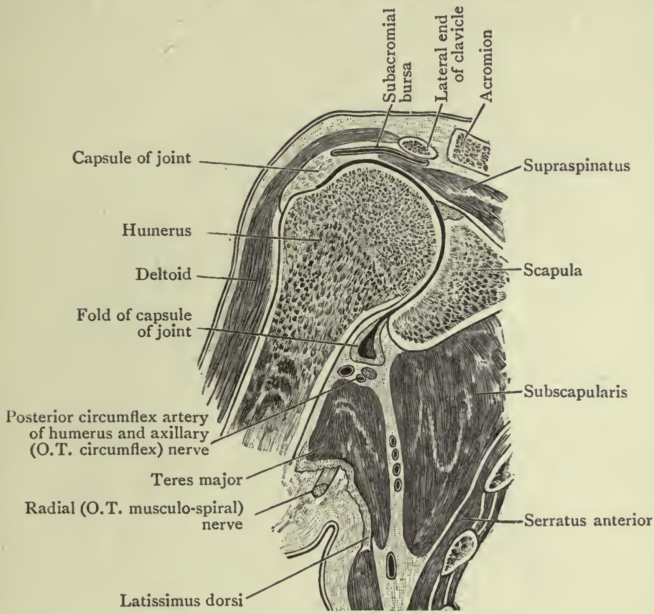


FIG. 50.—Frontal or vertical transverse section through the Left Shoulder-joint. (Viewed from behind.)

socket sub-group of the diarthrodial or completely movable joints. The socket is formed by the glenoid cavity of the scapula and the ball is the spheroidal head of the humerus.

In no joint in the body are the movements so free and so varied in their character as in the shoulder-joint. This is rendered necessary by the many functions which are performed by the upper limb. Freedom of movement is provided for in two ways—(1) by the large size of the head of the humerus, in comparison with the small dimensions and shallow character of the glenoid cavity; (2) by the great laxity of the ligamentous structures which connect the humerus with the scapula. These provisions for allowing an extensive range of movement at this articulation might, at first sight, lead one to doubt the security of the joint. Its strength certainly does not lie in the adaptation of the bony surfaces to one another, nor in the strength of its ligaments. It lies—(1) in the powerful muscles by which it is closely surrounded; (2) in the overhanging coraco-acromial arch, which forms, as it were, a

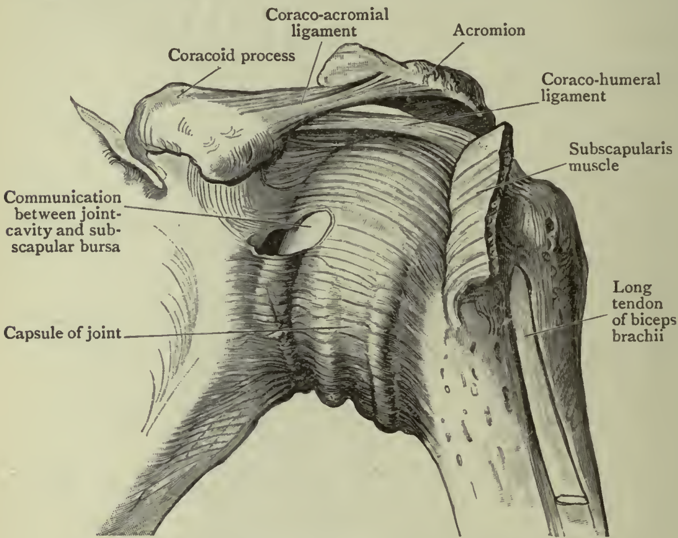


FIG. 51.—Shoulder-joint as seen from the front.

secondary socket for the head of the humerus, and effectually prevents any displacement in an upward direction; and (3) in atmospheric pressure, which exercises a powerful influence in keeping the opposed surfaces in contact with each other.

On all aspects, except over a small area below, the loose, ligamentous capsule which envelops the shoulder-joint is supported by muscles, the tendons of which are more or less intimately connected with it. *Above*, it is covered by the supraspinatus; *behind*, the infraspinatus and teres minor are applied to it; *in front* is the subscapularis. *Below*, the capsule is to a certain extent unsupported by muscles, and there it is prolonged downwards, in the form of a fold, in the ordinary dependent position of the limb (Figs. 50, 53). When, however, the arm is abducted, the fold is obliterated, and the head of the bone rests upon the inferior part of the capsule, which now receives partial support from two muscles which are stretched under it, viz. the long head of the triceps and the teres major. Still, this must be regarded as the weakest part of the joint, and consequently dislocation of the head of the humerus downwards into the axilla, through the inferior part of the capsule, is an occurrence of considerable frequency. When the dislocation occurs, the axillary vessels and nerve which lie close to the capsule may be injured.

Dissection.—The capsule of the shoulder-joint has already been exposed by the reflection of the muscles immediately adjacent to its anterior, superior, and posterior aspects, and the bursa between its anterior surface and the subscapularis has been examined. To expose the capsule more fully, untie the axillary vessels and nerves from the coracoid process ; cut through the tendon of origin of the coraco-brachialis and the short head of the biceps brachii and displace the muscles downwards. Cut through the teres major about its middle and the long head of the triceps about 25 mm. (one inch) distal to its origin and turn both muscles aside. Turn aside the divided subscapularis, supraspinatus, infraspinatus and teres minor muscles. Note that whilst the supraspinatus, infraspinatus and teres minor completely cover the upper and posterior part of the capsule, a small interval exists between the anterior border of the supraspinatus and the upper border of the subscapularis. In that interval the subacromial bursa is in relation with the capsule, and occasionally, but very rarely, a communication exists between the cavity of the bursa and the cavity of the joint. Re-examine the bursa which lies between the subscapularis and the front of the capsule, and note that its aperture of communication with the joint is situated near the root of the coracoid process. Thoroughly clean the outer surface of the capsule. Note the laxity of the capsule, and define its attachments to the margin of the glenoid cavity and to the lateral border of the root of the coracoid process.

The ligaments of the shoulder-joint are :—

Capsula articularis—
- Lig. coracohumerale.
- Lig. glenohumerale superius.
- ,, ,, ,, medium.
- ,, ,, ,, inferius.

Labrum glenoidale.

Capsula Articularis.—The *fibrous stratum* of the articular capsule is a fairly dense and strong membrane which envelops the articulation on all sides. It is attached to the scapula around the margin of the glenoid cavity, but is attached directly to the bone only at the upper part; elsewhere it blends with the outer surface of the labrum glenoidale, which is attached to the margin of the cavity for the purpose of increasing its depth. Laterally the capsule is attached to

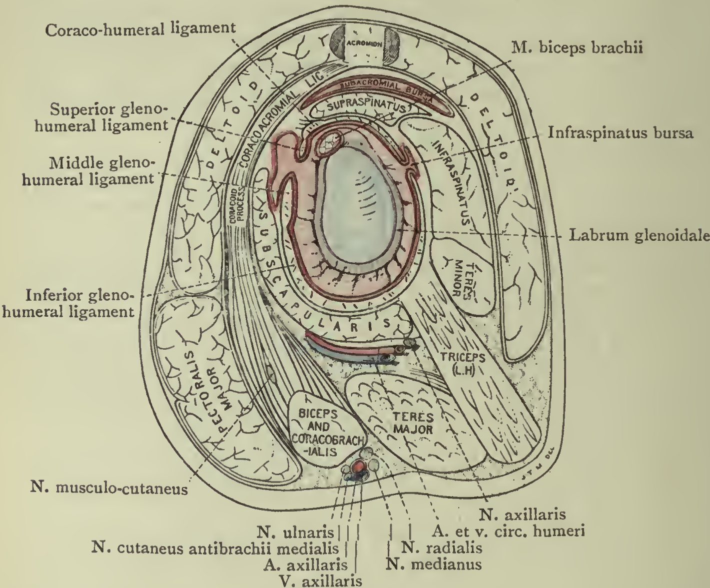


FIG. 52.—Semi-diagrammatic representation of a dissection of a Sagittal section through the Right Shoulder. The subscapular bursa is shown connected with the cavity of the joint between the superior and middle gleno-humeral bands of the articular capsule.

the anatomical neck of the humerus and to the transverse ligament of the humerus, which bridges across the top of the intertubercular sulcus from the greater to the lesser tubercle. The attachment of the upper part of the fibrous stratum to the humerus is quite close to the articular surface of the head, but the attachment of the lower part is some distance (12-16 mm.) from the articular surface; consequently a considerable part of the lower portion of the anatomical neck is inside the fibrous stratum of the capsule and is covered by the synovial stratum (Fig. 53). This cannot be seen until the capsule has been opened.

The fibrous stratum of the capsule is not complete at all points. Its continuity is always broken by two and sometimes by three or four apertures, and where the lateral margin of the fibrous stratum is attached to the transverse ligament of the humerus there is an aperture below the margin. Prolongations of the synovial stratum are protruded through

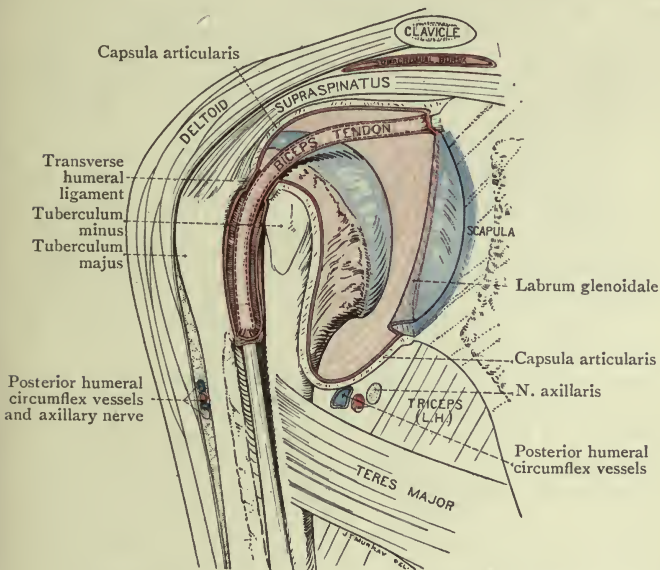


FIG. 53.—Diagram of a Frontal Section of the Right Shoulder

all the apertures which are present. The largest opening is in the antero-medial part near the root of the coracoid process, and the prolongation of the synovial stratum which passes through it forms the subscapular bursa, which separates the subscapularis from the front of the capsule and from the front of the neck of the scapula. The dissector should note carefully the size and the position of this opening because the head of the humerus is occasionally driven through it, instead of through the lower part of the capsule, when the joint is dislocated.

The second constant aperture is that below the transverse ligament of the humerus at the top of the intertubercular sulcus. It is much smaller than the aperture in front, and through it the tendon of the long head of the biceps, which springs from the apex of the glenoid cavity, emerges from the joint. The tendon is enclosed in a tubular prolongation of the synovial stratum which surrounds it and lines the intertubercular sulcus (Fig. 53). It is not often that a third opening is found in the fibrous stratum. It is situated, when present, in the postero-lateral part of the capsule and permits the protrusion of the synovial stratum to form a bursa under cover of the infraspinatus muscle (Fig. 52). Still more rarely the subacromial bursa communicates with the cavity of the joint through an opening which is situated between the supraspinatus and subscapularis muscles.

In four situations the fibrous stratum of the capsule is thickened by longitudinal bands of fibres which pass from the scapula to the humerus. One of the thickenings, the *coraco-humeral ligament*, can be seen from the exterior; the other three, the *gleno-humeral ligaments*, are thickenings of the inner surface of the fibrous stratum of the capsule and can be seen only from the interior of the joint.

Ligamentum Coracohumerale.—The coraco-humeral ligament is placed upon the superior aspect of the joint. It is a broad band of great strength, which is more or less completely incorporated with the capsule. Proximally, it is fixed to the root and lateral border of the coracoid process of the scapula, and it passes thence, obliquely distally and laterally, to gain attachment to the two tubercles of the humerus, and to the transverse humeral ligament, which forms a strong arch over the upper part of the intertubercular sulcus.

Ligamenta Glenohumeralia. — There are three gleno-humeral ligaments. To see them the posterior part of the capsule must be divided by a vertical incision and the head of the humerus must be turned aside or removed. The *superior gleno-humeral ligament* springs from the margin of the glenoid cavity immediately anterior to the tendon of the long head of the biceps brachii, and it passes to a small pit situated on the proximal extremity of the humerus close to the top of the intertubercular sulcus. The *middle gleno-humeral ligament* is attached to the scapula immediately above the notch on the anterior margin of the glenoid cavity, and to the humerus in the region of the small tubercle. Between it and the superior gleno-humeral ligament is the opening from the joint into the subscapular bursa. The *inferior gleno-humeral ligament* is a fan-shaped thickening. It is attached by its smaller extremity to the scapula below the notch in the anterior margin of the glenoid cavity, and, by its broader end, to the neck of the humerus along a line

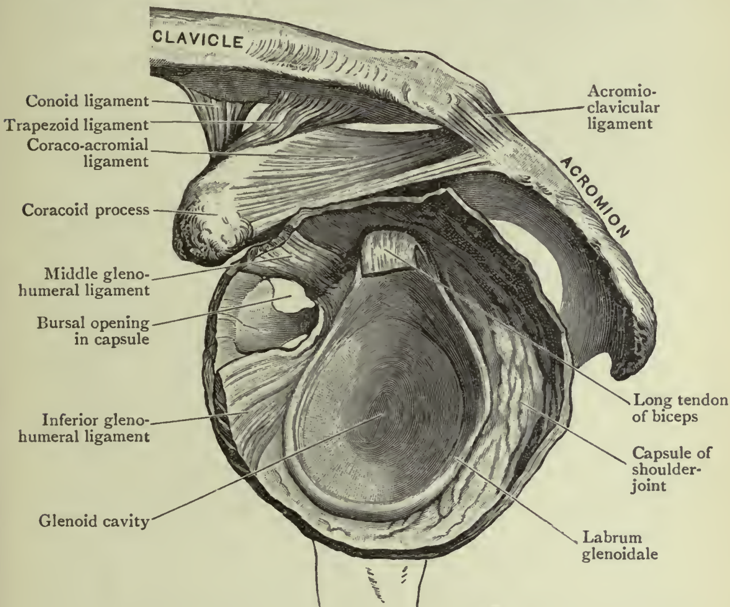


FIG. 54.—Shoulder-joint. The Articular Capsule has been cut across and the Humerus removed.

passing from a lower part of the lesser to the greater tubercle. It strengthens the lower and anterior part of the capsule which is situated above the quadrilateral space.

Dissection.—Complete the division of the capsular ligament, divide the tendon of the biceps brachii and draw it through the intertubercular aperture in the capsule, then separate the two bones from one another.

Labrum Glenoidale (O.T. **Glenoid Ligament**).—The labrum glenoidale is the dense fibro-cartilaginous band which surrounds the margin of the glenoid cavity of the scapula, and is attached to its rim. It deepens, and at the same time serves to extend, the articular socket of the scapula. The intimate connection which it presents with the capsule of the joint can now be studied. Two tendons are also closely associated with it, viz. the long head of the triceps brachii below, and the long head of the biceps brachii above.

Long Head of the Biceps.—The tendon of the long head of the biceps is an important factor in the mechanism of the shoulder-joint. It enters the capsule through the opening between the two tubercles of the humerus, and is prolonged over the head of the bone to the apex of the glenoid cavity. Its attachment to the scapula should now be examined. The tendon divides into three portions, viz. a large intermediate part, which obtains direct attachment to the scapula, and two smaller collateral parts, which diverge from each other and blend with the labrum glenoidale. The long head of the biceps brachii, by its position within the capsule and in the deep sulcus between the tubercles of the humerus, serves to keep the head of the bone in place, and to steady it in the various movements at the shoulder-joint.

The *synovial stratum* lines the fibrous stratum of the capsule of the joint, and is reflected from it upon the anatomical neck of the humerus as far as the articular margin of the head of the bone. The bursal protrusion of the *bursa subscapularis*, under the tendon of the subscapularis muscle, has already been noticed. The tendon of the biceps, as it traverses the joint, is enveloped in a tubular sheath of the membrane; this sheath bulges out through the opening of the capsule in the form of a bursa which lines the intertubercular sulcus (Fig. 53).

Articular Surfaces.—The smooth, glistening articular cartilage which coats the head of the humerus is thickest in the centre, and thins as it passes towards the edges. In the case of the glenoid cavity the reverse of this will be noticed.

Movements at the Shoulder-joint.—The shoulder is a ball-and-socket joint (enarthrosis), and consequently movement in every direction is permitted, viz.—(1) *flexion*, or forward movement; (2) *extension*, or backward movement (checked in its extent by the coraco-humeral ligament); (3) *abduction*, or lateral movement (checked by the coraco-acromial arch); (4) *adduction*, or medial movement (limited

PLATE V

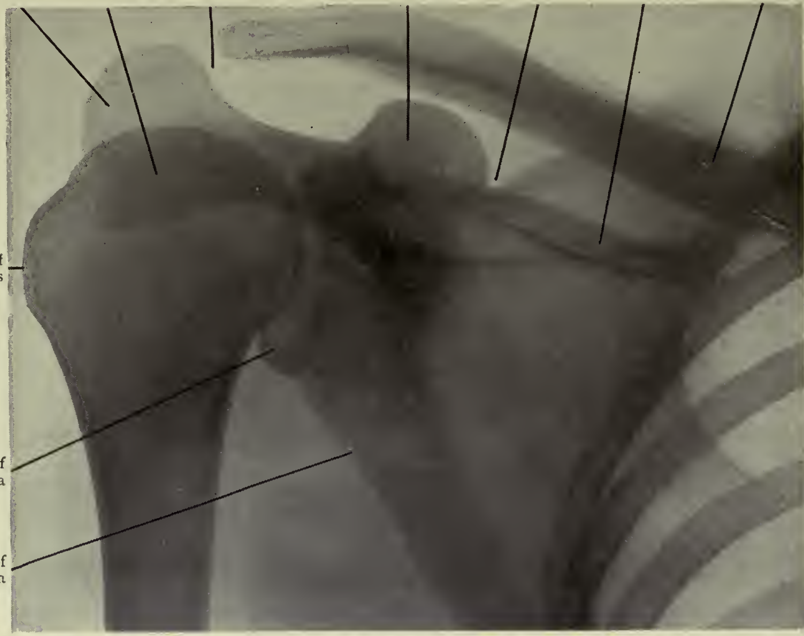


FIG. 55.—Radiograph of Shoulder Region with Arm by Side.

Note the relation of the acromion to the head and the greater tubercle of the humerus and compare with Figs. 56*a*, 56*b*.

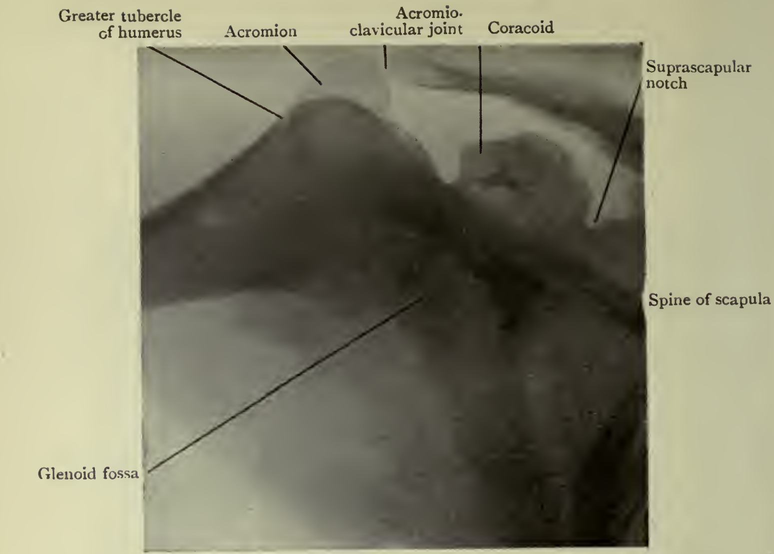


FIG. 56*a*.—Radiograph of Shoulder Region with Arm fully abducted.

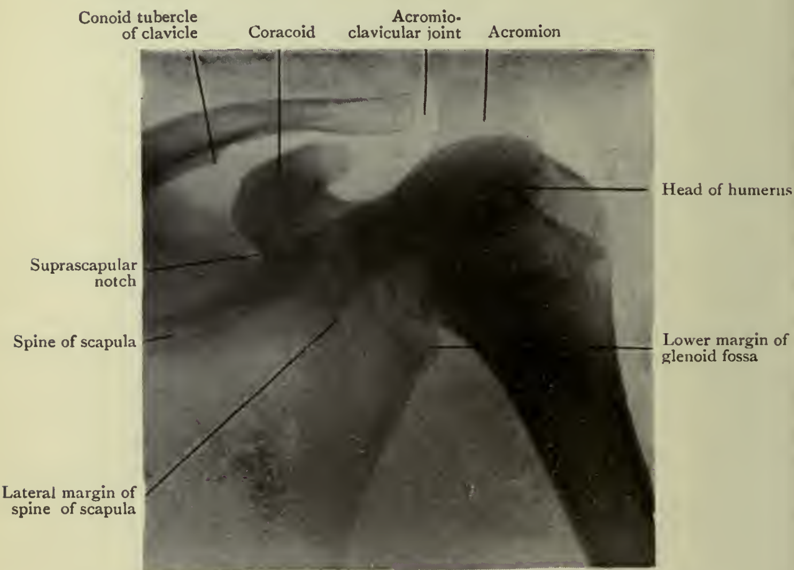


FIG. 56*b*.—Radiograph of Shoulder Region with Arm partly abducted.
Note (1) That the glenoid fossa is always directed slightly upwards.
(2) The relative positions of the head of the humerus and the greater tubercle to the acromion. Compare with Fig. 55.

by the coraco-humeral ligament). By combination of the angular movements, in regular sequence, *circumduction* is produced; and *rotation* of the humerus, to the extent of quarter of a circle, occurs also.

The **muscles** chiefly concerned in producing these movements are:—*flexion*—the pectoralis major and the anterior part of the deltoid; *extension*—latissimus dorsi, posterior part of the deltoid, and the teres major; *abduction*—the deltoid and supraspinatus; *adduction*—pectoralis major, coraco-brachialis, teres major, and latissimus dorsi; *rotation medially*—subscapularis, pectoralis major, latissimus dorsi, teres major; *rotation laterally*—infraspinatus, and teres minor; *circumduction* is produced by the action of different combinations of these muscles.

The relations of the capsule are shown in Figs. 52, 53.

FOREARM AND HAND.

The skin has already been removed from the forearm and hand, and the cutaneous veins and nerves have been exposed and studied, but before proceeding with the deeper dissection the dissector should re-examine the cutaneous veins and nerves.

Venæ Superficiales.—The two large superficial veins, the basilic and the cephalic, both spring from the venous arch on the dorsum of the hand in which the superficial veins from the fingers terminate (p. 63), and they are reinforced by numerous tributaries from the dorsal and volar surfaces of the limb. The basilic vein curves round the proximal part of the ulnar border of the forearm on its way towards the arm, whilst the cephalic vein turns round the distal part of the radial border (Figs. 31, 32).

Nervi Cutanei.—*Two nerves* supply the skin of the volar aspect of the forearm: *the volar branch of the medial cutaneous nerve of the forearm* on the medial side, and the *lateral cutaneous continuation of the musculo-cutaneous nerve* on the lateral side.

Three nerves supply the skin on the dorsal aspect of the forearm: *the dorsal branch of the medial cutaneous nerve of the forearm* on the medial side, branches of the *lateral cutaneous nerve* on the lateral side, whilst the intermediate area is supplied by *the distal branch of the dorsal cutaneous nerve of the forearm*, which is a branch of the radial nerve.

Four nerves supply the skin of the palm of the hand: in the region of the hypothenar eminence *the palmar cutaneous branch of the ulnar nerve*, in the region of the thenar eminence *the lateral cutaneous nerve of the forearm*, and a twig from the *superficial division of the radial nerve*, whilst the intermediate part is supplied by *the palmar cutaneous branch of the median nerve.*

Two nerves supply branches to the skin of the dorsum of the hand: on the lateral part *the superficial branch of the radial nerve*, and on the medial part *the dorsal branch of the ulnar nerve.*

Two nerves supply the skin of the volar aspects of the digits: *the median* and *the ulnar*. Three and a half digits fall to the digital branches of the median nerve: the thumb, the index, the middle, and the lateral half of the ring finger; and one and a half to the digital branches of the ulnar nerve, the little finger and the medial half of the ring finger.

Three nerves supply the skin of the dorsal aspects of the digits. Speaking generally, the proximal halves of the thumb, the index, middle, and half the ring finger are supplied by branches of *the superficial division of the radial nerve.* The distal halves of the index, middle, and half the ring finger are supplied by twigs of *the digital branches of the median nerve*, and the remaining half of the ring finger and the little finger receive twigs from *the ulnar nerve.*

After the cutaneous veins and nerves have been re-examined the deep fascia of the forearm should be thoroughly cleaned, if that has not already been done, and its special points should be re-studied.

Fascia Antibrachii (Fascia of the Forearm).—The deep fascia which envelops the forearm is of considerable strength and density. More particularly is that the case on the dorsal aspect of the limb. In its proximal part it receives an accession of fibres from the tendon of the biceps brachii, in the form of the lacertus fibrosus. Some fibres are given to it by the tendon of the triceps also. Near the elbow it serves as a surface of origin for the numerous muscles which spring from the epicondyles of the humerus, and from its deep aspect dense septa pass between the fleshy bellies. The septal partitions are indicated on the surface by a series of white lines. At the wrist it becomes continuous, anteriorly, with the *volar carpal ligament* and the *transverse carpal ligament* (O.T. *ant. annular lig.*), whilst posteriorly it forms an obliquely placed, thickened band, the *dorsal carpal ligament* (post. annular lig.).

Volar Surface and Medial Border of the Forearm.

In this dissection the following structures will be displayed:—

1. The radial and ulnar arteries and their branches.
2. The median and ulnar nerves and their branches.
3. The deep branch and the superficial branch of the radial nerve.
4. The group of pronator and flexor muscles.

Dissection.—The deep fascia must now be removed from the forearm. Make two incisions through it, (1) a transverse incision at the proximal border of the transverse carpal ligament; (2) a longitudinal incision from the apex of the cubital fossa to the transverse incision. As the transverse incision is made be careful not to injure the palmar cutaneous branches of the median and ulnar nerves, the tendon of the palmaris longus, the ulnar nerve and artery, and the mucous sheaths of the flexors. The two palmar cutaneous nerves and the tendon of the palmaris longus and the ulnar nerve and artery pierce the deep fascia proximal to the transverse ligament and pass across its superficial surface, but the ulnar nerve and artery are bound down to the ligament by a more superficial band called the *volar carpal ligament*, which passes from the pisiform bone to the front of the transverse carpal ligament. The volar carpal ligament is apt to be mistaken for the transverse ligament, but the mistake should not be made, because the volar carpal ligament lies superficial to the ulnar artery and nerve, whilst the transverse ligament is deep to those structures. Retain the volar carpal ligament in the meantime. The mucous sheaths of the tendons lie immediately subjacent to the deep fascia. Turn the two flaps marked out by the incisions to their respective sides, dividing the septa which pass from their deep surfaces between the adjacent muscles. Both flaps can be followed to the dorsal border of the ulna, to the whole length of which the deep fascia is attached, but for the present do not reflect the lateral flap beyond the radial border of the forearm. Near the elbow the muscles which spring from the medial and lateral epicondyles gain additional origin from the deep surface of the fascia. Where that is the case the fascia must be left *in situ*, for attempts to remove it will only result in laceration of the muscles.

Muscles of the Volar Aspect of the Forearm.—The muscles of the volar aspect of the forearm are arranged in a superficial and a deep group. They comprise the flexors of the wrist and digits, and also the pronators of the forearm.

In the *superficial group* are the brachio-radialis, pronator teres, the flexor carpi radialis, the palmaris longus, and the flexor carpi ulnaris, in that order from the lateral to the medial side. On a deeper plane lies the fleshy belly of the flexor digitorum sublimis which only partially comes to the surface. The *deep group* is composed of three muscles, placed in contact with the bones and interosseous membrane of the forearm, viz., the flexor digitorum profundus, in relation to the ulna, the flexor pollicis longus, in relation to the radius, and the pronator quadratus, closely applied to the distal ends of both bones. The brachio-radialis lies along the lateral border of the volar aspect.

The brachio-radialis extends from the lateral supra-condylar ridge of the humerus to the distal end of the radius. The pronator teres ends at the middle of the radius. The flexor carpi radialis passes to the ball of the thumb, where its tendon disappears into a cleft in the lateral border of the transverse carpal ligament. The tendon of the palmaris longus lies medial to the tendon of the flexor carpi radialis; it passes anterior to the transverse carpal ligament to join the intermediate part of the palmar aponeurosis. Still more medial, descending to the pisiform bone, is the tendon of the flexor carpi ulnaris. The tendons of the flexor digitorum sublimis, enclosed in their mucous sheath, lie deep to the palmaris longus between the flexor carpi radialis and the flexor carpi ulnaris.

Dissection.—Clean the brachio-radialis, from its origin from the humerus to its insertion into the base of the styloid process of the radius. To expose the insertion it will be necessary to push backwards the tendons of the abductor pollicis longus and the extensor pollicis brevis which overlap it posteriorly. Pull the brachio-radialis aside and clean the radial artery and its branches and the superficial branch of the radial nerve.

Arteria Radialis.—The radial artery is the smaller of the two terminal branches of the brachial artery, but its direction gives it the appearance of being the continuation of the parent trunk in the forearm. It takes origin in the cubital fossa, opposite the neck of the radius, and it proceeds distally, in the lateral part of the front of the limb, until it reaches the distal end of the radius. There it turns round the lateral border of the wrist and leaves the present dissection. At first it lies between the pronator teres and the brachio-radialis, and is overlapped to some extent on the lateral side by the fleshy belly of the latter muscle (Fig. 61). At a more distal level it is placed between the brachio-radialis, on the lateral side, and the flexor carpi radialis, upon the medial side; and that position it maintains as far as the wrist. Where the muscles mentioned are fleshy the artery lies at some depth from the surface; but when their tendons appear it assumes a superficial position, and is covered merely by the integument and fasciæ. Throughout its whole length it is closely accompanied by the *venæ comites*, and the superficial division of the radial nerve lies along its lateral side in the middle third of the forearm. More proximally, the nerve is separated from the vessel by a slight interval; whilst distally, the nerve leaves the artery and turns round the lateral margin of the forearm, under cover of the tendon of the brachio-radialis.

Posteriorly, the radial artery is supported by the muscles which clothe and find attachment to the front of the radius. At its origin it rests upon the tendon of the biceps brachii; next it lies in front of the supinator, with some adipose tissue intervening; thence distally it is in contact with the pronator teres, the thin radial head of the flexor digitorum sublimis, the flexor pollicis longus, the pronator quadratus, and, lastly, the distal end of the radius.

The radial artery is usually selected for the determination of the *pulse*. When the tips of the fingers are placed upon the distal part of the forearm, in the interval between the tendons of the brachio-radialis and flexor carpi radialis, the pulsations of the vessel, in the living person, can readily be felt.

Branches of the Radial Artery.—In the forearm the radial artery gives off the following branches, viz.:—

1. The a. recurrens radialis.
2. The a. volaris superficialis.
3. The a. carpea volaris radialis.
4. Rami musculares.

The *muscular branches* are very numerous, and proceed from the radial artery, at irregular points, throughout its whole course in the forearm (Fig. 62).

The *radial recurrent artery* is a branch of some size. It takes origin close to the commencement of the radial artery, and, in the first instance, runs laterally between the brachio-radialis and the supinator. There it comes into relation with branches of the radial nerve, and gives off several twigs for the supply of the muscles arising from the lateral epicondyle of the humerus. Somewhat reduced in size, it now turns proximally, in the interval between the brachio-radialis and brachialis, and ends, in front of the lateral epicondyle of the humerus, by anastomosing with the anterior terminal branch of the profunda brachii artery. It may be represented by two or more vessels.

The *superficial volar artery* is a small, variable branch, which arises a short distance proximal to the wrist, and runs distally to end in the muscles of the ball of the thumb. Sometimes, however, it attains a larger size and a special importance, because it is continued into the palm to complete the superficial volar arch, on the lateral side.

The *volar radial carpal artery* is a minute twig which springs from the radial at the distal border of the pronator quadratus muscle. It runs medially, under cover of the flexor tendons, and joins with the corresponding branch of the ulnar artery to form the *volar carpal arch.*

The Ramus Superficialis and **the Ramus Profundus of the Nervus Radialis** (O.T. **Radial and Posterior Interosseous Nerves**).—It has already been noted that the radial nerve ends proximal to the elbow, under cover of the brachio-radialis muscle, by dividing into two terminal branches, the superficial branch and the deep branch. Both branches may now be studied in so far as they lie in the volar part of the forearm. The *ramus profundus* soon disappears from view by passing backwards, on the lateral side of the radius, through the fibres of the supinator muscle.

The *superficial branch* proceeds distally, under cover of the fleshy belly of the brachio-radialis. In the middle third of the forearm it lies along the lateral side of the radial artery; then it leaves the artery and winds round the lateral margin of the limb, under cover of the tendon of the brachio-radialis. It has been traced in the rest of its course (p. 71). The superficial branch is a purely cutaneous nerve; and it gives off no branches until it gains the dorsal aspect of the distal part of the forearm.

Dissection.—Before the cleaning of the superficial flexor muscles is commenced an attempt should be made to demonstrate the mucous sheaths of the flexor tendons. They are the common sheath of the flexor digitorum sublimis and the flexor digitorum profundus, the sheath of the flexor pollicis longus and the sheath of the flexor carpi radialis.

If the sheaths are uninjured they can be distended with air by means of a blowpipe, or by fluid forced in through a syringe. If they have been injured they can still be explored with a blunt probe.

Examine, first, the common sheath of the flexor tendons of the fingers. Pick up a fold of the medial part of its anterior wall within the forceps, and introduce the blowpipe or the needle of the syringe into the base of the fold. Notice that as

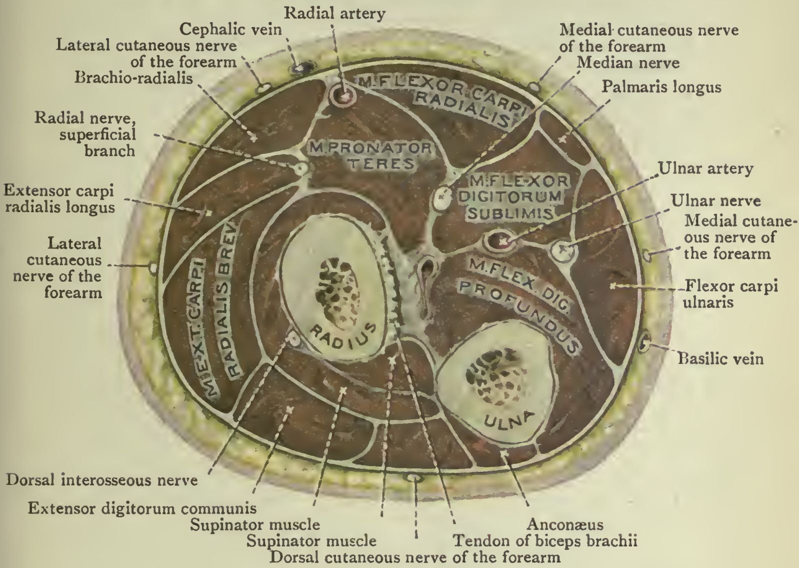


FIG. 57.—Transverse section through the Proximal Third of the left Forearm.

the air or fluid enters it the sheath is distended, at first proximally, to about 25 mm. above the transverse carpal ligament, then the distension passes distally, behind the transverse carpal ligament, to the middle of the palm and along the little finger, as far as the terminal phalanx, showing that the common flexor sheath is continuous with the flexor sheath of the little finger. It may also extend along the thumb, for, in a certain number of cases, the sheath of the flexor pollicis longus communicates with the common flexor sheath.

The sheath of the flexor carpi radialis is not easily distended because it is enclosed for the greater part of its extent in an osteo-fibrous canal. It extends from a short distance proximal to the transverse carpal ligament to the base of the metacarpal bone of the index finger. Open it at the proximal border of the ligament and investigate its course and direction with the aid of a blunt probe.

If the sheath of the flexor pollicis longus has not already been distended by the air or fluid thrown into the common flexor sheath, pull the tendon of the flexor carpi radialis medially, find the tendon of the flexor pollicis longus which lies behind it, and either distend its sheath in the manner indicated or examine it with a probe. It extends from one inch above the transverse carpal ligament to the base of the terminal phalanx of the thumb.

Now turn to the middle finger and make a small longitudinal incision through the flexor sheath opposite the middle of the second phalanx. A blunt probe introduced through the incision can be passed distally to the base of the terminal phalanx and proximally to the level of the head of the metacarpal bone. The conditions are the same in the cases of the index and ring fingers, therefore the digital sheaths of the index, middle, and ring fingers do not communicate with the common flexor sheath. If the digital sheath of the little finger is opened in a similar manner no difficulty will be experienced in passing a probe along it into the common flexor sheath, and if the digital sheath of the thumb is opened and a little care exercised a probe can be passed along it, and behind the transverse carpal ligament, to the proximal limit of the mucous sheath of the flexor pollicis longus tendon.

Mucous Sheaths of the Flexor Tendons.—As the tendons of the flexor digitorum sublimis, the flexor digitorum profundus, and the flexor pollicis longus pass behind the transverse carpal ligament they are accompanied by the median nerve and they are enveloped in two mucous sheaths (Fig. 58). One sheath surrounds the flexor pollicis longus, the other surrounds the tendons of both the flexor sublimis and the flexor profundus, and it may enclose also the median nerve. The sheaths, therefore, line a "carpal tunnel" which is bounded superficially by the transverse carpal ligament and dorsally by the carpal bones, and they greatly facilitate the free play of the tendons between the transverse carpal ligament and the carpus. As already stated, the sheaths are two in number. Both sheaths are prolonged proximally, into the forearm, for 25 mm. (one inch) or more, and both are carried distally into the palm in the form of diverticula upon the diverging tendons. The diverticula in relation to the tendons which go to the index, middle, and ring fingers end near the middle of the palm. Those upon the tendons of the thumb and little finger, however, are prolonged distally into the digits, and line the fibrous sheaths which confine the tendons upon the volar aspects of the phalanges (Fig. 57).

The mucous sheath which invests the tendons of the flexor

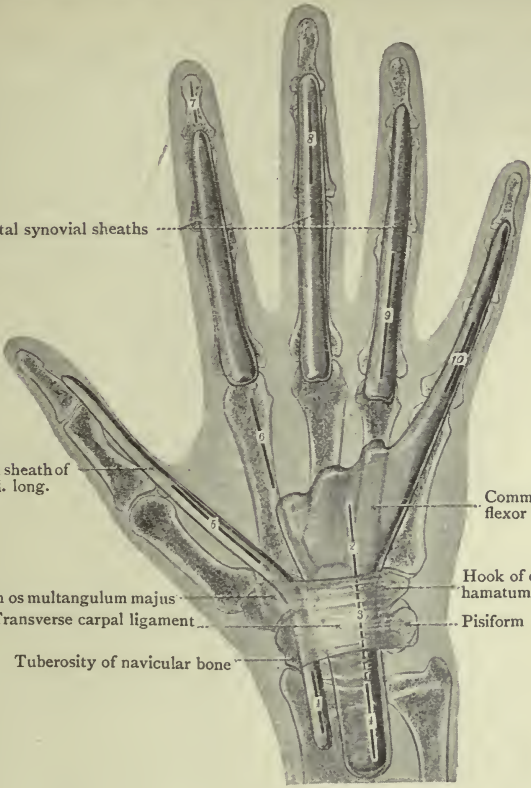


FIG. 58.—The Synovial Sheaths of the Wrist and Hand. The positions of various incisions for the evacuation of pus are also shown.

1 and 2. Incisions into the common palmar sheath, placed between the median and ulnar nerves.
3. Incision uniting 1 and 2.
4. Incision into the proximal part of the sheath of flexor pollicis longus. It is placed between the radial artery and the median nerve.
5. Incision into the distal part of the sheath of flexor pollicis longus.
6. Incision into the thenar space.
7. Incision over terminal phalanx.
8, 9 and 10. Incisions into the digital sheaths. They lie opposite the shafts of the phalanges.

digitorum sublimis and flexor digitorum profundus is sometimes divided by a vertical partition into two compartments, and the lateral of them communicates, by means of a small aperture near the proximal border of the transverse carpal ligament, with the mucous sheath of the tendon of the flexor pollicis longus.

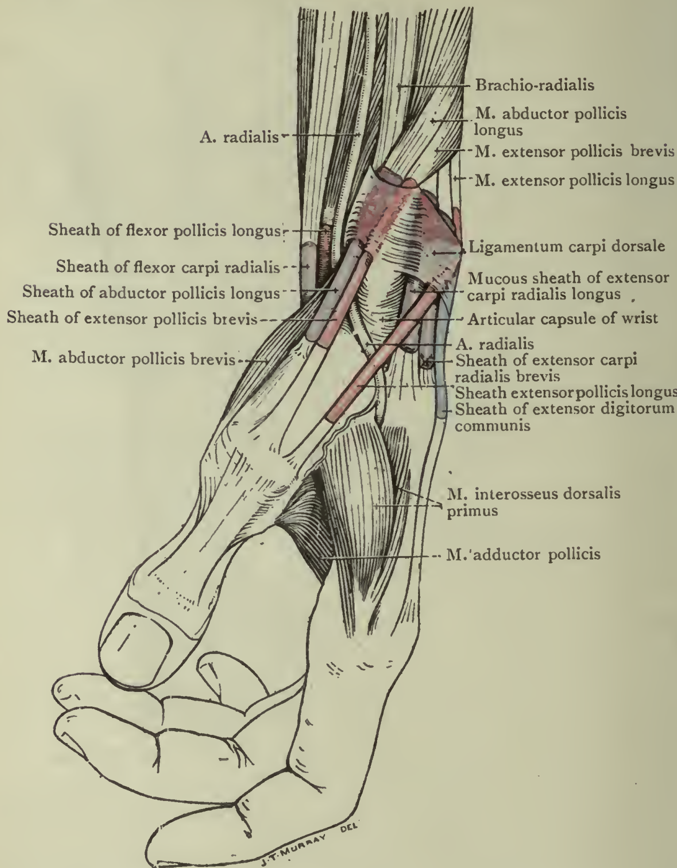


FIG. 59.—Dissection of the Lateral Side of the Left Wrist and Hand showing Mucous Sheaths of Tendons.

The Constitution of Mucous Sheaths of Tendons.—The student should understand the nature of mucous sheaths which surround tendons, where they pass through fascial or osteo-fascial canals. The majority of the mucous sheaths are double-walled tubes. At their extremities the outer and inner walls are bound together, and the space between the two walls, the so-called cavity of the sheath, is thus closed. The cavity of the sheath is a potential cavity only, and it contains merely sufficient mucous fluid to lubricate the adjacent surfaces, and facilitate their free play over one another.

The inner wall of the tube surrounds the tendon and adheres to its surface. The outer wall lines the canal through which the tendon passes and adheres to it. But the ends of the sheaths project beyond the limits of the canals which they line; therefore, as the tendons move

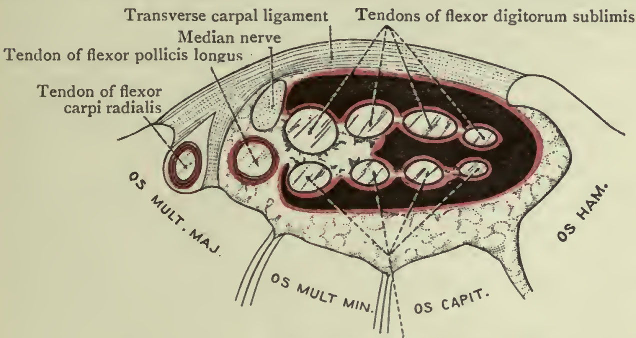


FIG. 60.—Diagram illustrating the relation of the Synovial Sheaths to the Flexor Tendons at the level of the transverse carpal ligament.

proximally and distally, the opposite ends of the sheaths can be invaginated and evaginated, thus allowing for the free play of the tendons.

When a sheath becomes inflamed the adjacent surfaces of its two walls are at first roughened, and when the tendon moves, friction, which can be heard and felt, occurs and pain is caused. Then the fluid between the two walls increases in amount, the sheath becomes distended as if it had been injected, and its position becomes apparent. At the same time the friction ceases, but the distension of the walls stretches the nerves, and pain is still felt.

Some mucous sheaths, for example the mucous sheath of the flexors of the fingers, are not complete tubes, but merely invaginated sacs (Fig. 60).

Dissection.—The superficial muscles which arise from the medial epicondyle of the humerus must now be cleaned. Commence with the most lateral of the group, the pronator teres, and follow it from its origin to its insertion into the middle of the lateral surface of the radius. To expose the insertion the brachio-radialis and the long and short radial extensors of the carpus which cover it must be pulled aside. As the distal part of the pronator teres is being cleaned be careful not to injure the thin radial origin of the flexor digitorum sublimis which lies behind it. Separate the proximal part of the pronator teres from the flexor carpi radialis by dividing the intermuscular septum between them. Divide the superficial head of the pronator teres, turn the proximal part towards the medial epicondyle and the distal part towards the radius and follow the deep head between the median nerve and the ulnar artery to its origin from the coronoid process of the ulna. After the pronator teres has been examined clean the flexor carpi radialis, but do not follow its tendon of insertion beyond the proximal edge of the transverse carpal ligament, where it enters a special osteo-fibrous canal through which it will be traced in a later dissection. Now clean the palmaris longus; trace its tendon to the intermediate part of the palmar aponeurosis, and note that as it crosses the transverse carpal ligament its deep surface is attached to the ligament.[1]

The most medial muscle of the group, the flexor carpi ulnaris, must now be cleaned. Note that its tendon of insertion lies along the volar border of the distal part of the muscle. This is a point of practical importance, for the tendon is used as a guide during operations upon the ulnar nerve and artery in the distal part of the forearm. Clean both heads of origin of the flexor carpi ulnaris, one from the medial epicondyle and one from the medial border of the olecranon of the ulna, and note that the ulnar nerve, accompanied by the superior ulnar collateral artery, disappears between them. Separate the proximal part of the flexor carpi ulnaris from the adjacent parts of the palmaris longus and the flexor digitorum sublimis by splitting the septa between them; secure the ulnar nerve and its branches to the flexor carpi ulnaris and the flexor digitorum profundus on the deep surface of the flexor carpi ulnaris. Follow the ulnar nerve distally. At the junction of the proximal and middle thirds of the forearm it is joined by the ulnar artery, which appears from under cover of the medial border of the flexor digitorum sublimis. Clean the artery and nerve, as far as the lateral side of the pisiform bone, and find the origins of the dorsal and palmar branches of the nerve, which were seen when the superficial structures of the palm and on the dorsum of the hand were dissected (p. 70). Secure also the volar carpal branch of the artery which arises near the proximal border of the transverse carpal ligament.

To get a good view of the flexor digitorum sublimis divide the palmaris longus and the flexor carpi radialis at the middle of the forearm. Turn the proximal parts of both the muscles upwards and separate them from the pronator teres and the flexor sublimis by splitting the intervening intermuscular septa.

[1] The palmaris longus is not uncommonly absent.

Pull the pronator teres laterally and secure the median nerve as it emerges between the superficial and deep heads of the muscle and before it disappears between the radial and humeral parts of the flexor digitorum sublimis. Then clean the flexor sublimis, being careful not to injure the thin sheet of fibres by which it takes origin from the volar border of the radius. Clean the four tendons in which the flexor sublimis terminates. They are arranged in pairs, two anterior which pass to the middle and ring fingers, and two posterior for the index and little fingers. Pull upon the tendons and note the results. Note also that the median nerve, after it emerges from between the two heads of the pronator teres, disappears again between the humeral and radial origins of the flexor sublimis to reappear at the lateral border of the muscle a short distance proximal to the wrist, where it lies under cover of the radial border of the tendon of the palmaris longus. The tendons of the flexor digitorum sublimis must not be followed further than the transverse carpal ligament at present. The terminal parts will be displayed in a later dissection.

Common Origin of the Superficial Muscles.—The five muscles which constitute the superficial group are very closely associated with each other at the elbow—indeed, they may be said to arise by a common origin from the front of the medial epicondyle of the humerus. In addition they all derive fibres from the investing deep fascia of the limb, near the elbow, and from the strong fibrous septa which pass between the muscles from the deep surface of investing fascia. The pronator teres, the flexor sublimis, and the flexor carpi ulnaris, have additional heads of origin (Figs. 61, 62).

M. Pronator Teres.—The pronator teres muscle crosses the proximal half of the front of the forearm obliquely. It arises by two heads, viz., a humeral and an ulnar. The *humeral head* constitutes the chief bulk of the muscle. It springs from the proximal part of the medial epicondyle of the humerus, and also slightly, by fleshy fibres, from the distal part of the medial epicondylar ridge. The fascia covering it and the fibrous septum on its medial side also contribute fibres. The *ulnar head* is placed deeply, and it may be recognised from the fact that it intervenes between the median nerve and the ulnar artery. The ulnar head is very variable in size. As a rule, it is a small fleshy slip, but sometimes it is chiefly fibrous. It arises from the medial border of the coronoid process of the ulna (Fig. 64, p. 147), and soon joins the deep surface of the humeral head. The muscle, thus formed, passes obliquely distally and laterally, and ends in a tendon which gains insertion into a rough impression upon the middle of the lateral surface of the radius (Fig. 64,

p. 147). This attachment is placed on the summit of the chief curve of the radius, an arrangement which enables the muscle to exercise its pronating action at a great advantage. Close to its insertion the pronator teres is crossed by the radial artery and it is covered by the brachio-radialis muscle. It is supplied by the *median nerve*. It is a pronator of the forearm and hand and a flexor of the elbow.

M. Flexor Carpi Radialis.—The flexor carpi radialis arises from the common tendon, from the fascia of the forearm and the fibrous septa which intervene between it and the adjacent muscles. Its fleshy belly gives place, a short distance distal to the middle of the forearm, to a long flattened tendon, which, at the wrist, traverses the groove on the front of the os multangulum majus, in a special compartment of the transverse carpal ligament (Fig. 60, p. 137). It is inserted into the volar aspect of the base of the metacarpal bone of the index, and slightly also into the base of the metacarpal bone of the middle finger. Its relations to the transverse carpal ligament, and also its attachment to the metacarpus, will be exposed and studied at a later stage of the dissection. It is a flexor of the wrist and elbow joints and assists in producing abduction of the hand. It is supplied by the *median nerve.*

M. Palmaris Longus.—The palmaris longus is a long slender muscle, which is not always present. It springs from the common origin, the fascial investment of the forearm and the fibrous septum on each side of it. Its tendon pierces the deep fascia immediately proximal to the wrist, and then passes distally, superficial to the transverse carpal ligament, to join the strong intermediate portion of the palmar aponeurosis. Very frequently it gives a slip to the abductor pollicis brevis. It is supplied by the *median nerve*, and is a flexor of the radio-carpal and elbow joints.

M. Flexor Carpi Ulnaris.—The ulnar flexor of the carpus muscle arises by two heads. One of them is incorporated with the common origin from the medial epicondyle; the other springs from the medial border of the olecranon of the ulna, and also by an aponeurotic attachment from the dorsal border of the same bone in its proximal two-thirds. Fibres are derived also from the investing fascia and the intermuscular septum on its lateral side. The two heads of origin of the flexor carpi ulnaris bridge across the interval between

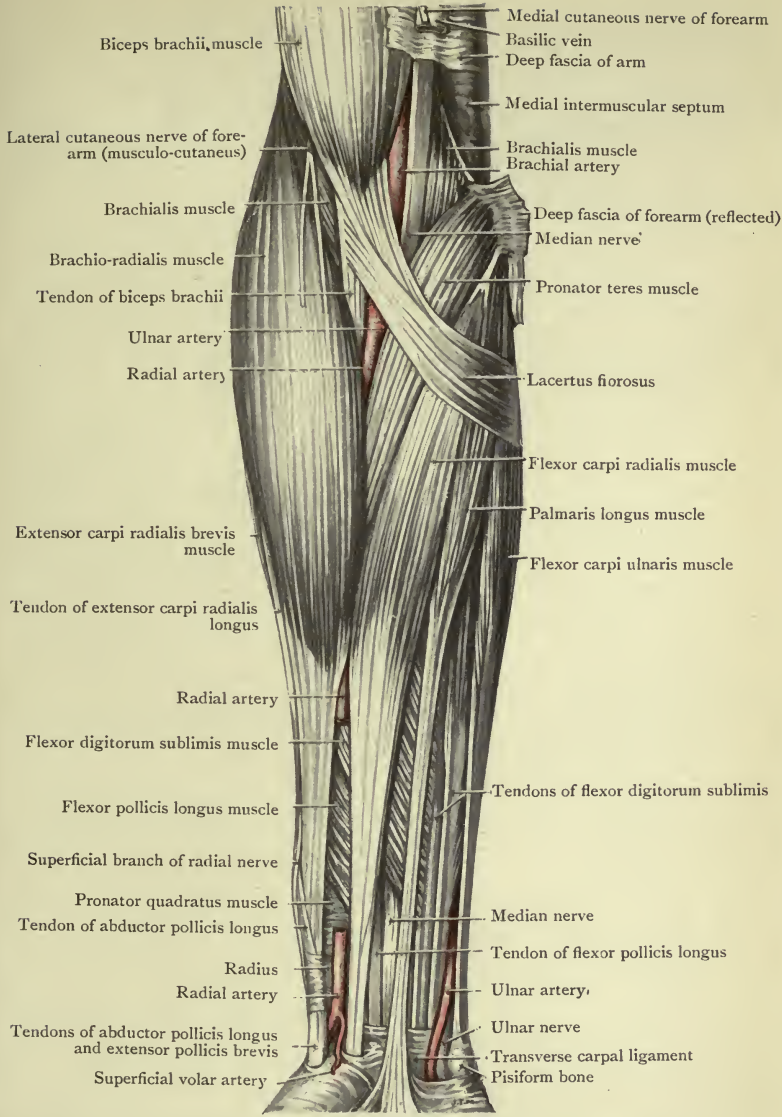


FIG. 61.—Superficial Dissection of the Muscles, Arteries, and Nerves of the Anterior Aspect of the Forearm.
Part of the radial artery was removed to show some of its deep relations.

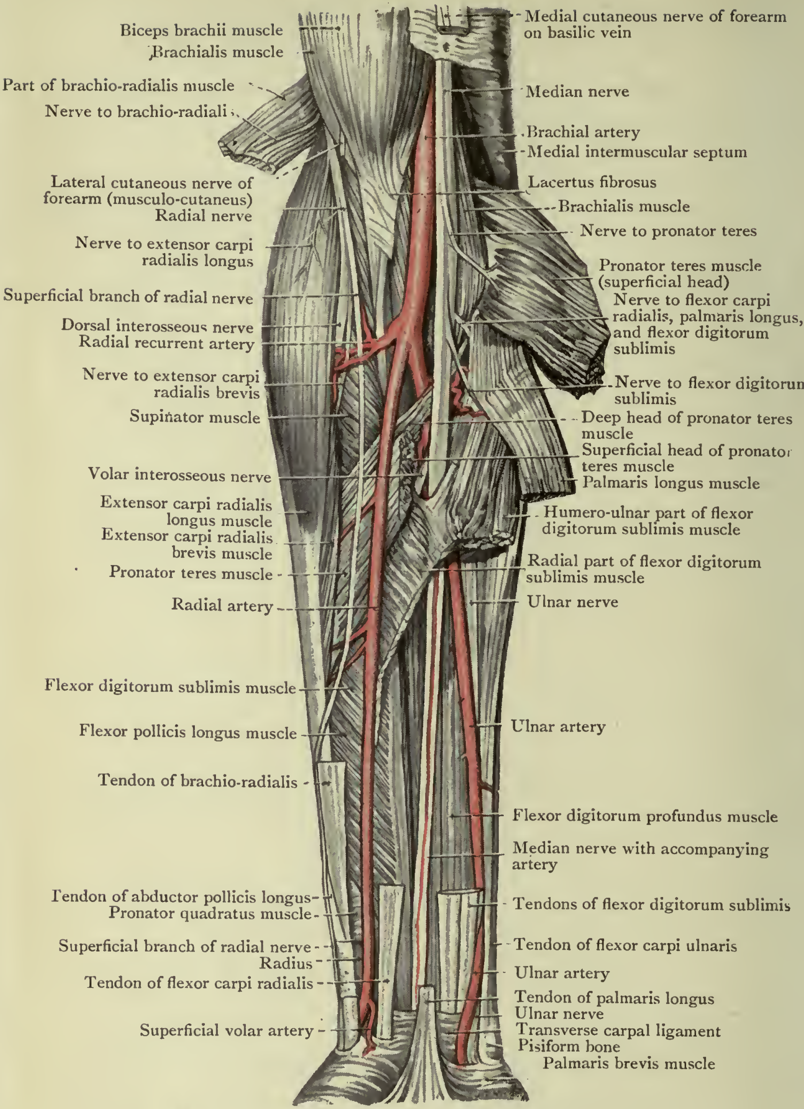


FIG. 62.—Deep Dissection of the Muscles, Vessels, and Nerves of the front of the Forearm.

the medial epicondyle of the humerus and the olecranon, and between them the ulnar nerve is prolonged distally into the forearm. The tendon appears upon the volar border of the muscle, and is inserted into the pisiform bone. The flexor carpi ulnaris is supplied by the *ulnar nerve*. It is a flexor and adductor of the hand and a flexor of the elbow.

M. Flexor Digitorum Sublimis.—The flexor sublimis receives this name because it is placed upon the superficial aspect of the flexor profundus. For the most part it lies deeper than the other superficial muscles (Fig. 61). It is a powerful muscle which arises from the medial epicondyle of the humerus by the common tendon; it takes origin also from the ulnar collateral ligament of the elbow-joint, from the medial margin of the coronoid process of the ulna, the volar surface of the radius (Figs. 45, 64), and the fascial intermuscular septa in relation to it. The radial head of origin is a thin fleshy stratum which is attached to the volar border of the radius, from its proximal end to a variable distance beyond the insertion of the pronator teres muscle. Four tendons issue from the fleshy mass; they enter the palm by passing under cover of the transverse carpal ligament, and go to the medial four digits. Their insertions will be seen later, but, in the meantime, note that at the wrist, and for a short distance proximal to it, they are enveloped by the mucous sheath previously mentioned, and also that, as they pass behind the transverse carpal ligament, they lie in pairs—the tendons to the ring and middle fingers being placed on the volar aspect of those for the index and little fingers. The flexor digitorum sublimis is supplied by the *median nerve*. It is a flexor of the first interphalangeal joints of the fingers, the metacarpo-phalangeal joints, the wrist joint, and the elbow joint.

The dissector who examines the flexor digitorum sublimis in detail will find that the part which arises from the humerus divides into a superficial and a deep portion, and that each portion subdivides in two parts, a lateral and a medial. The lateral part of the superficial portion unites with fibres which spring from the radius; then the combined fibres pass to the tendon for the middle finger. The medial part of the superficial portion receives additional fibres from the deeper portion, and ends in the tendon for the ring finger. The lateral part of the deeper portion is a digastric muscle; it ends in the tendon for the index finger. The medial part of the deeper portion ends in the tendon for the little finger; it is a small muscular belly which frequently receives fibres from the intermediate tendon of the lateral part of the deeper portion of the muscle.

Dissection.—Cut through the radial part of the flexor digitorum sublimis at its union with the humeral portion. Pull the main mass of the muscle towards the medial side of the forearm, and turn the radial portion towards its origin. Then clean the median nerve, the branch of the anterior interosseous artery which accompanies the nerve, and the anterior surface of the flexor pollicis longus which springs from the volar surface of the radius; and the flexor digitorum profundus, which arises from the volar and medial surfaces of the ulna. Then secure the volar interosseous branch of the median nerve. It springs from the median nerve as the latter emerges from between the two heads of the pronator teres. Find also the common interosseous branch of the ulnar artery. It arises in, or immediately distal to, the cubital fossa, and must be looked for behind the deep head of the pronator teres. Almost at once it divides into volar and dorsal interosseous branches. The dorsal branch passes backwards above the interosseous membrane to the dorsal part of the forearm, where it will be dissected later. Now separate the adjacent borders of the flexor pollicis longus and the flexor digitorum profundus and follow the volar interosseous artery and nerve to the point where they disappear behind the pronator quadratus in the distal third of the forearm. Clean the pronator quadratus, then proceed to study the structures exposed.

Arteria Ulnaris.—The ulnar artery is the larger of the two terminal branches of the brachial trunk. It takes origin, in the cubital fossa, at the level of the neck of the radius. In the proximal third of the forearm it inclines obliquely distally and medially, and then it proceeds straight down to the wrist. It enters the palm by passing anterior to the transverse carpal ligament. In the proximal oblique portion of its course the vessel is deeply placed, and is crossed by both heads of the pronator teres, the flexor carpi radialis, the palmaris longus, the flexor digitorum sublimis and the median nerve. Its distal, vertical part is overlapped on the medial side by the flexor carpi ulnaris, but a short distance proximal to the wrist it becomes superficial, and lies in the interval between the tendon of the flexor carpi ulnaris on the medial side and the tendons of the flexor sublimis on the lateral side. As it lies on the transverse carpal ligament it is separated from the lateral side of the pisiform bone by the ulnar nerve, and is covered by a strong band of fascia, the volar carpal ligament (pp. 129, 162), which lies superficial to the transverse ligament. Throughout its entire course it is accompanied by two *venæ comites.* It has important relationships with the median and ulnar nerves. The *median nerve*, which lies upon its medial side at its origin, soon crosses it, but at the point of crossing the nerve is separated from the artery by the deep head of the pronator teres. The *ulnar nerve* in the proximal third of the forearm is separated from the vessel by a wide interval, but in the distal two-thirds of the forearm it closely accompanies the artery, and lies on its medial side.

In the cubital fossa the ulnar artery rests upon the brachialis; more distally it is in contact posteriorly with the flexor digitorum profundus; whilst at the wrist the artery lies upon the superficial surface of the *transverse carpal ligament.*

Branches of the Ulnar Artery.—In the forearm the ulnar artery gives off the following branches:—

1. A. recurrens ulnaris volaris.
2. A. recurrens ulnaris dorsalis.
3. A. interossea communis.
4. A. carpea volaris.
5. A. carpea dorsalis.
6. Rami musculares.

The *muscular branches* are of small size, and come off at variable points for the supply of the neighbouring muscles.

The *volar ulnar recurrent artery* (O.T. *anterior ulnar recurrent*) is the smaller of the two recurrent branches. It runs proximally, anterior to the medial epicondyle of the humerus, in the interval between the pronator teres and the brachialis muscles, and it anastomoses with the anterior terminal branch of the inferior ulnar collateral artery.

The *dorsal ulnar recurrent artery* (O.T. *posterior ulnar recurrent*) passes medially, under cover of the flexor digitorum sublimis, and then turns proximally, between the two heads of origin of the flexor carpi ulnaris, to gain the interval between the medial epicondyle of the humerus and the olecranon, on the dorsal aspect of the limb. There it becomes associated with the ulnar nerve, and anastomoses with the posterior terminal branch of the inferior ulnar collateral artery and with the superior ulnar collateral artery.

It is not uncommon to find the two recurrent arteries arising from the ulnar trunk by a short common stem.

The *common interosseous artery* is a short, wide trunk, which takes origin immediately distal to the recurrent branches, about 25 mm. (one inch) from the commencement of the ulnar artery. It passes dorsally to the proximal margin of the interosseous membrane, where it divides into two terminal branches, viz., the *volar* (O.T. *anterior*) and the *dorsal* (O.T. *posterior*) *interosseous arteries.*

The *arteria interossea dorsalis* passes backwards above the proximal border of the interosseous membrane to the dorsal part of the forearm, where it will be dissected at a later period.

The *arteria interossea volaris* descends on the anterior surface of the interosseous membrane, between the adjacent margins of the flexor pollicis longus and the flexor digitorum profundus, which must be separated as the artery is followed. At the proximal border of the pronator quadratus it pierces the interosseous membrane and passes to the dorsal part of the forearm, where its terminal part will be seen at a later period. As it descends on the volar surface of the interosseous membrane it gives twigs to the adjacent muscles, and the following named branches :—

1. Arteria mediana.
2 and 3. Nutrient to radius and ulna.
4. Volar communicating.

The *arteria mediana* is a long slender vessel which accompanies the median nerve to the palm of the hand, where it sometimes terminates in the superficial volar arch. The *nutrient arteries* enter the nutrient foramina of the radius and ulna. The *volar communicating artery* descends on the volar surface of the interosseous membrane, deep to the pronator quadratus, to the carpus, where it terminates in the volar carpal arch.

The *ulnar carpal arteries* are two small arteries, which partially encircle the wrist. The *volar ulnar carpal artery* runs laterally, under cover of the tendons of the flexor digitorum profundus, and anastomoses with the volar carpal branch of the radial artery. From the arch, thus formed, small twigs are given to the volar aspect of the carpal bones and joints. The *dorsal ulnar carpal artery* gains the dorsal aspect of the carpus by winding round the medial margin of the limb immediately proximal to the pisiform bone, and under cover of the tendon of the flexor carpi ulnaris.

Nervus Ulnaris.—The ulnar nerve, which was traced in the dissection of the arm as far as the interval between the olecranon and medial epicondyle of the humerus, enters the forearm between the two heads of the flexor carpi ulnaris. It proceeds distally, on the volar surface of the flexor digitorum profundus and under cover of the flexor carpi ulnaris, in the volar part of the medial side of the forearm. Close to the wrist it becomes superficial, upon the lateral side of the

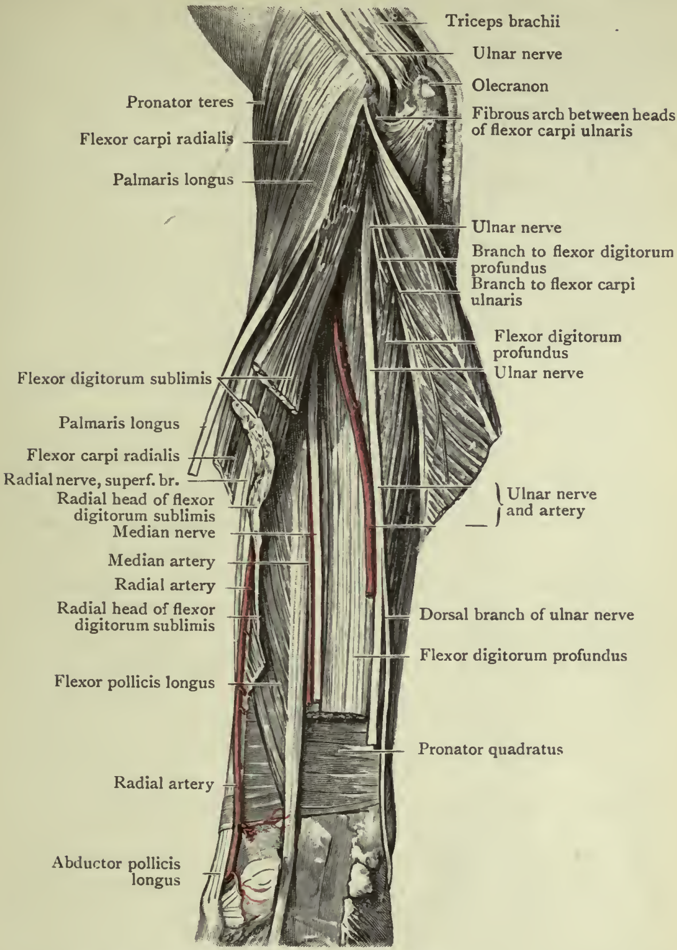


FIG. 63.—Dissection of the volar aspect of the Forearm; the superficial muscles are cut short and turned aside, and the deeper parts are still further displayed by the separation of the flexor digitorum sublimis from the flexor carpi ulnaris along the line of the intermuscular septum which intervenes between them.

tendon of the flexor carpi ulnaris, and it reaches the palm by passing superficial to the transverse carpal ligament. In the proximal third of the forearm the ulnar nerve is separated from the ulnar artery by a considerable interval, but in the distal two-thirds it is closely applied to the medial side of the vessel.

In the forearm the ulnar nerve gives off:—

1. Rami articulares.	
2. Rami Musculares,	to the flexor carpi ulnaris and the medial part of the flexor digitorum profundus.
3. Rami cutanei,	ramus cutaneus palmaris. ramus dorsalis manus.

The *articular branches* spring from the ulnar nerve as it lies in the interval between the olecranon and the medial epicondyle of the humerus, and pass to the elbow-joint.

The *muscular branches* are given off immediately distal to the articular branches. They supply the flexor carpi ulnaris and the medial part of the flexor digitorum profundus.

The *palmar cutaneous branch* is a minute twig which has already been seen piercing the fascia of the forearm, immediately proximal to the transverse carpal ligament. It arises about the middle of the forearm and proceeds distally upon the ulnar artery, to be distributed in the palm of the hand.

The *dorsal branch* is a nerve of some size which springs from the ulnar trunk about 6–7·5 cm. (two and a half or three inches) proximal to the wrist. It winds round the medial margin of the forearm, under cover of the flexor carpi ulnaris, and reaches the dorsum of the hand immediately distal to the prominence formed by the distal end of the ulna. From that point onwards it has been traced in the superficial dissection (p. 71).

Nervus Medianus.—As its name implies, the median nerve passes down the middle of the forearm.

In the proximal part of the forearm the median nerve lies in the cubital fossa upon the medial side of the ulnar artery. It leaves the fossa by passing between the two heads of the pronator teres, and as it does so it crosses the ulnar artery, but is separated from it by the ulnar head of the muscle. From that point the median nerve runs distally between the flexor digitorum sublimis superficially and the flexor digitorum profundus deeply. Near the wrist it becomes superficial, and lies in the interval between the tendons of the palmaris longus, on the medial side, and the flexor carpi radialis, on the lateral side. Finally it leaves the forearm by passing deep to the transverse carpal ligament. A small artery, the *a. mediana*, a branch of the volar interosseous artery, accompanies the median nerve. Sometimes this vessel attains a considerable size.

As the median nerve enters the forearm it gives off numerous branches for the supply of muscles, and near the wrist it supplies a *palmar branch*, which has already been dissected (p. 70).

The *muscular branches* supply all the muscles which spring from the medial epicondyle of the humerus, with the single exception of the flexor carpi ulnaris; viz., the pronator teres, the flexor carpi radialis, the palmaris longus, and the flexor digitorum sublimis.

It supplies also a long slender twig—*volar interosseous nerve*—which goes to the deep muscles on the volar aspect of the forearm.

Deep Structures on the front of the Forearm.—The connections of the deep muscles must now be studied.

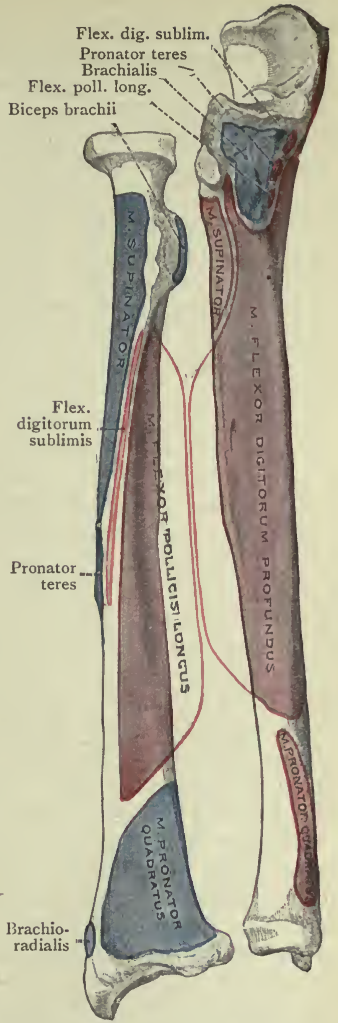


FIG. 64.—Volar aspect of Bones of Forearm with Muscular Attachments mapped out.

The flexor digitorum profundus is the large muscle which clothes the volar and medial surfaces of the ulna; the flexor pollicis longus is placed upon the volar surface of the radius; while the pronator quadratus is a quadrate fleshy layer closely applied to both bones immediately proximal to the wrist. The volar interosseous artery and nerve proceed distally in the interval between the flexor profundus and flexor pollicis longus.

M. Flexor Digitorum Profundus.—The deep flexor of the fingers springs from the volar and medial surfaces of the ulna in its proximal three-fourths. It derives fibres also from the volar surface of the interosseous membrane and the aponeurosis by which the flexor carpi ulnaris takes origin from the dorsal border of the ulna. The fleshy mass gives place to four tendons for the medial four digits, but only one of them—that for the index finger—becomes separate and distinct in the forearm. The tendons proceed distally, *deep to* the transverse carpal ligament, into the palm. The flexor digitorum profundus is supplied by the *volar interosseous branch of the median* and by the *ulnar nerve.* It is a flexor of all the joints of the fingers, and of the wrist.

M. Flexor Pollicis Longus.—The flexor pollicis longus arises from the proximal two-thirds of the volar surface of the radius. It takes origin also from the adjacent part of the volar surface of the interosseous membrane. A rounded tendon issues from the fleshy belly, and proceeds into the palm, deep to the transverse carpal ligament.

In many cases the flexor pollicis longus has an additional slender head of origin, which springs from the medial border of the coronoid process of the ulna, or the medial epicondyle of the humerus. The flexor pollicis longus is supplied by the *volar interosseous nerve.* It is a flexor of all the joints of the thumb and of the wrist.

M. Pronator Quadratus.—The quadrate pronator muscle takes origin from the distal fourth of the volar surface of the ulna, and is inserted into the distal third of the volar surface of the radius. It is supplied by the *volar interosseous nerve.* It is pronator of the forearm and hand.

Dissection.—Divide the pronator quadratus vertically and clean the part of the volar interosseous artery which lies behind it.

Wrist and Palm.

In this dissection the following structures will be found:—

1. Palmaris brevis muscle and the palmar cutaneous nerves.
2. Palmar aponeurosis.
3. Superficial volar arch and its branches.
4. Median and ulnar nerves and their branches.
5. Volar carpal ligament, transverse carpal ligament, the flexor tendons, and their mucous sheaths.
6. The lumbrical muscles.
7. Short muscles of the thumb and little finger.
8. Deep volar arch and its branches.
9. Princeps pollicis artery and radial volar artery of the index finger.

Before proceeding with the dissection of the palm the student should revise the surface anatomy of the region, making use of his own hands as well as of his "part" for the purpose; and he should re-study the superficial vessels and nerves, and the deep fascia which have already been displayed (p. 73). After the revision is completed, the attachments and relations of the palmaris brevis muscle must be noted.

Surface Anatomy.—In the centre of the palm the depression, known as the "hollow of the hand," may be noted. Along the medial border of the palm the hollow is bounded by a rounded elevation, called the *hypothenar* eminence, which is produced by the subjacent short, intrinsic, muscles of the little finger. The *thenar* eminence, or ball of the thumb, formed by the short muscles of that digit, is the marked prominence which limits the palmar hollow proximally and on the lateral side; whilst the transverse elevation at the roots of the fingers, which corresponds to the metacarpo-phalangeal articulations, constitutes the distal boundary of the central palmar depression. Two pronounced bony projections on the anterior aspect of the wrist cannot fail to attract attention when the hand is bent dorsally. The more prominent of the two is situated at the proximal extremity of the thenar eminence, and is formed by the tubercle of the navicular bone and the vertical ridge on the volar surface of the os multangulum majus; the other is placed at the proximal end of the hypothenar eminence, and is somewhat obscured by the soft parts attached to it. It is caused by the pisiform bone, and when taken firmly between the finger and thumb a slight degree of gliding movement can be communicated to it. Traversing the thick integument of the palm, three strongly marked furrows are apparent. One begins at the elevation formed by the navicular and os multangulum majus and curves distally and laterally, round the base of the thenar eminence, to the lateral margin of the hand. A second crosses the palm transversely. Commencing at the middle of the lateral border of the hand, where the first furrow ends, it runs medially, but, as a general rule,

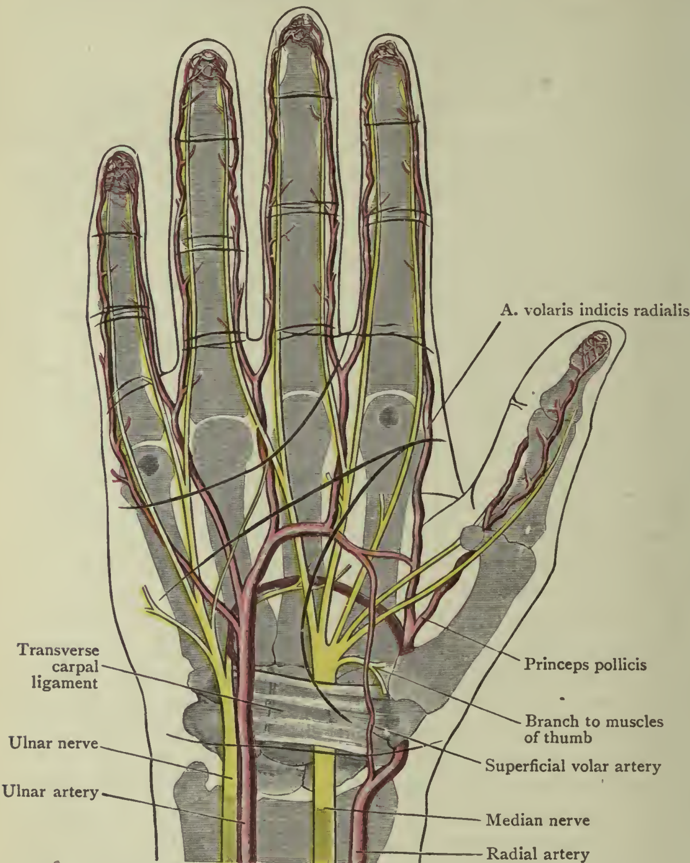


FIG. 65.—Diagram of Nerves and Vessels of Hand in relation to Bones and Skin Markings.

it fades away upon the hypothenar eminence. The third furrow begins near the cleft between the index and middle fingers, and proceeds medially, with a gentle curve across the hypothenar eminence, to the medial margin of the hand. The transverse cutaneous furrows at the roots of the fingers, and on the palmar aspects of the interphalangeal joints, should also be noticed. The furrows at the roots of the fingers are

FIG. 66.—Superficial Dissection of the Palm. The intermediate part of the palmar aponeurosis has been left in position, whilst the lateral and medial portions have been removed to display the short muscles of the thumb and little finger.

placed over the palmar aspects of the proximal phalanges, about 25 mm. (one inch) distal to the metacarpo-phalangeal joints. The proximal of the two furrows on the front of a proximal interphalangeal joint is placed immediately over the articulation, whilst in the case of the distal interphalangeal joints the single crease which is usually present is situated immediately proximal to the articulation. On the back of the hand the metacarpal bones can be readily felt, whilst their distal extremities, or heads, form the prominences known as the "knuckles."

M. Palmaris Brevis.—This small cutaneous muscle consists of a series of fasciculi which are frequently separated from one another by distinct intervals. As a whole it forms a thin fleshy layer which covers the deep fascia on the proximal one and a half inches of the hypothenar eminence. It springs from the distal margin of the transverse carpal ligament and the medial border of the strong intermediate part of the palmar aponeurosis, and it is inserted into the skin of the medial border of the hand. It lies superficial to the ulnar artery, the superficial part of the ulnar nerve, and to the deep fascia covering the muscles of the hypothenar eminence. It is supplied by the superficial division of the ulnar nerve.

Dissection.—Reflect the palmaris brevis to its origin from the intermediate part of the palmar aponeurosis, and secure the branch from the superficial division of the ulnar nerve which supplies it. Remove the medial part of the palmar aponeurosis from the muscles of the hypothenar eminence. Clean the ulnar artery to the point where it disappears under cover of the intermediate part of the palmar aponeurosis. Note that, as it passes by the *medial side* of the hook of the os hamatum, it sends a deep branch into the substance of the palm. Clean the ulnar nerve as it lies on the medial side of the hook of the hamatum and secure its two terminal branches: (1) A superficial branch, which divides into the digital branch for the medial side of the little finger, and a branch which divides to supply the adjacent sides of the little and ring fingers; and (2) a deep branch which accompanies the deep branch of the ulnar artery into the depths of the palm. Find the branches which the deep division of the ulnar nerve gives to the short muscles of the little finger; then insert the handle of the scalpel into the cleft into which the deep divisions of the artery and nerve pass, and carry it distally to separate the abductor digiti quinti muscle, on the medial side, from the flexor digiti quinti brevis and the opponens digiti quinti on the lateral side. The opponens lies on a deeper plane than the short flexor.

Short Muscles of the Little Finger.—There are three short muscles of the little finger: the abductor, the short flexor, and the opponens. They are all supplied by the deep branch of the *ulnar nerve.*

M. Abductor Digiti Quinti.—The abductor is the largest of the three short muscles of the little finger. It arises from the pisiform bone, and is inserted into the medial side of the base of the first phalanx of the little finger.

M. Flexor Digiti Quinti Brevis. — The short flexor of the little finger is a muscle of very variable size. It springs from the hook of the os hamatum and the adjacent part of the distal border of the transverse carpal ligament, and is inserted, with the abductor digiti quinti, into the medial side

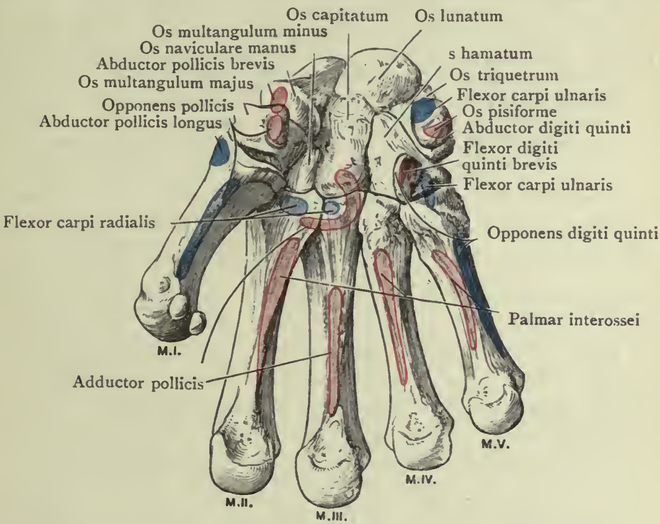


FIG. 67.—Volar aspect of the Bones of the Carpus and Metacarpus with Muscular Attachments mapped out.

of the base of the first phalanx of the little finger. It is not uncommonly incorporated, to a greater or less extent, with the opponens digiti quinti.

M. Opponens Digiti Quinti.—The opponens of the little finger lies on a deeper plane than the short flexor. It arises from the hook of the os hamatum and the distal border of the transverse carpal ligament, and is inserted into the whole length of the medial part of the volar aspect of the metacarpal bone of the little finger.

Dissection.—After the short muscles of the little finger have been studied, clean away the slip of the palmar aponeurosis

which goes to the thumb, taking care to avoid injury to the digital nerves of the thumb. Next separate the apex of the intermediate part of the palmar aponeurosis from the tendon of the palmaris longus and from the transverse carpal ligament, and reflect the intermediate part of the aponeurosis distally to the roots of the fingers. Do not fail to note that, from its medial and lateral margins, septa pass dorsally into the palm separating the muscles of the thenar and hypothenar eminences from the tendons of the long flexors of the fingers. The septa must be divided as the aponeurosis is reflected. Continue the reflection until the deep surfaces of the processes which pass to the fingers are fully exposed. Note that, at the roots of the fingers, each process divides into two slips. As the two slips pass dorsally they form an arch over the two flexor tendons which pass into the tendon sheath of the finger, and they become attached to the sheath of the tendons, to the transverse ligament which binds the heads of the metacarpal bones together, and to the deep fascia of the dorsum of the finger. Define the distal border of the transverse carpal ligament, but leave in position the part of the volar carpal ligament which binds the ulnar artery and nerve to the volar aspect of the transverse carpal ligament.

The structures exposed by the reflection of the intermediate part of the palmar aponeurosis are the contents of the intermediate compartment of the palm. They are:

1. The continuation of the ulnar artery as the superficial volar arch.
2. The digital branches from the arch to the clefts between the fingers and to the medial side of the little finger.
3. The terminal branches of the median nerve.
4. The branch of the superficial division of the ulnar nerve to the adjacent sides of the ring and little fingers.
5. The flexor tendons, surrounded by their mucous sheath.
6. The proximal parts of the mucous sheaths of the index, middle, and ring fingers.
7. The four lumbrical muscles.

Fascial Compartments of the Palm.—The two septa which pass from the margins of the intermediate part of the palmar aponeurosis into the depths of the palm have been noted as they were divided. They join a layer of fascia which lies on the volar surfaces of the interosseous muscles and the adductor of the thumb and the deep volar arterial arch. There are, therefore, in the palm, three fascial compartments, which lie deep to the palmar aponeurosis. (1) An intermediate compartment which contains the flexor tendons, the lumbrical muscles, the superficial volar arch and its branches, and the terminal branches of the median

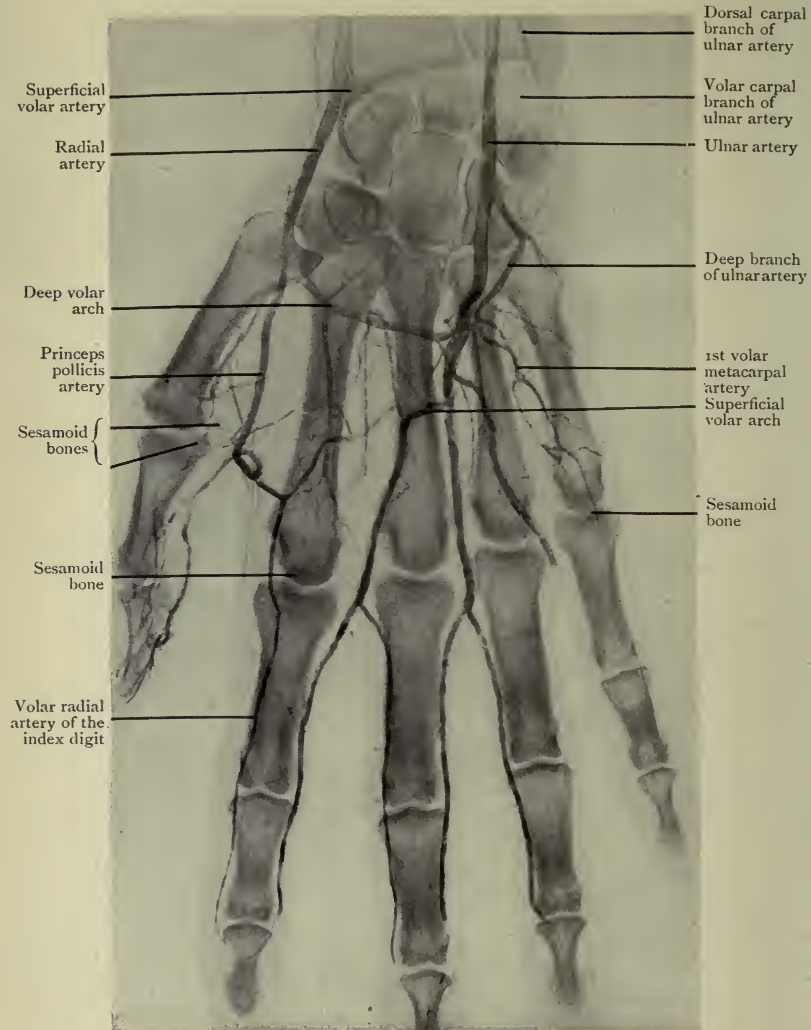


FIG. 68.—Radiograph of a Hand in which the Arteries were injected.

Note (1) That the injection is incomplete.

(2) That the superficial volar arch is formed by the anastomosis of the superficial branch of the ulnar artery with the princeps pollicis artery.

(3) That the volar radial artery of the index finger is a branch of the superficial volar arch.

(4) The relation of the deep volar arch to the metacarpal bones.

nerve; (2) a medial compartment enclosing the short muscles of the little finger, and the superficial division of the ulnar nerve; (3) a lateral compartment enclosing the muscles of the thumb. Fluid or pus which collects in the intermediate compartment can spread into the forearm behind the transverse carpal ligament, and distally to the clefts between the fingers, but it is excluded from the lateral and medial compartments by the septa which pass into the palm from the margins of the intermediate part of the palmar aponeurosis.

Dissection.—**Clean the superficial volar arch from the ulnar to the radial side, where it is completed by the anastomosis of the ulnar artery either with the superficial volar branch of the radial artery, with the radialis indicis, or with a branch of the princeps pollicis artery. Clean also the four digital branches which the arch gives to the fingers. Then clean the palmar part of the median nerve and its branches. The median nerve enters the palm at the distal border of the transverse carpal ligament. There it is flattened from before backwards and expanded from side to side. It divides, almost immediately, into two branches, a smaller lateral and a larger medial. Follow the lateral branch first. Soon after its origin it gives off, from its lateral side, a stout branch to supply the short muscles of the thumb. Secure that branch at once, and follow it across the superficial surface of the flexor pollicis brevis to the point where it disappears under cover of the abductor pollicis brevis. More distally the lateral branch of the median nerve divides into three digital branches, two for the thumb and one for the radial side of the index finger. No especial care is needed as the branches to the thumb are cleaned, but the branch to the index finger gives a fine twig to the first lumbrical which will be destroyed unless care is exercised. The larger medial division of the median nerve divides into two branches, one for the adjacent sides of the index and middle fingers, and one for the adjacent sides of the middle and ring fingers. Care must be exercised as each is cleaned, for the first gives a fine twig to the second lumbrical muscle which should not be missed, and the second is connected with the lateral branch of the superficial division of the ulnar nerve by a communicating twig which should be secured now if it was not found when the ulnar nerve was cleaned.**

Arcus Volaris Superficialis (O.T. **Superficial Palmar Arch**).—The term superficial volar arch is applied to an arterial arcade which lies immediately subjacent to the intermediate part of the palmar aponeurosis, its most distal point being situated at the level of the distal border of the fully abducted thumb. It is formed by the ulnar artery. That artery crosses the volar surface of the transverse carpal ligament, immediately lateral to the pisiform bone, then it passes across the medial side of the apex of the hook of the os hamatum. A short distance distal to the hook of the os hamatum it turns laterally, pierces the septum which separates the medial from the intermediate fascial compartment of the palm, and crosses the intermediate compartment, lying between the intermediate part of the palmar aponeurosis, which is superficial to it, and the terminal branches of the median nerve and the flexor tendons, which are deep to it. At the lateral border of the intermediate fascial compartment it unites with a branch of the radial artery, either the superficial volar, or the radialis indicis, or the princeps pollicis. The arch lies, therefore, in the medial and intermediate fascial compartments of the palm. In the medial compartment it lies upon the flexor brevis and opponens digiti quinti muscles and is covered by the palmaris brevis. In the intermediate compartment it lies upon the flexor tendons and the digital branches of the median nerve, and it is covered by the intermediate part of the palmar aponeurosis.

As the ulnar artery lies on the transverse carpal ligament, before it becomes the superficial volar arch, it gives off a *profunda branch* which passes deeply into the palm, with the deep division of the ulnar nerve, between the abductor digiti quinti muscle medially and the flexor digiti quinti brevis laterally. That branch will be traced in the deep dissection of the palm. From the superficial arch itself small twigs are given off to the adjacent tendons and fascia, but the chief branches are the *four digital arteries* which spring from the convexity of the arch. The first of the four remains undivided. It runs to the medial border of the little finger, along which it passes to the terminal phalanx. The other three branches, 2nd, 3rd, 4th, pass towards the interdigital clefts, where each divides, at the level of the bases of the first phalanges, into two branches, which supply the sides of the adjacent fingers, the second supplying the little and ring fingers, the third the ring and middle, and the fourth the middle and index fingers (Figs. 68, 69).

There are certain practical points to be noted in association with the digital arteries. The first crosses the lateral branch of the superficial division of the ulnar nerve and the short muscles of the little finger The undivided parts of the second, third, and fourth lie in line with the interdigital clefts between the fingers; each is situated between a pair of flexor tendons and is superficial to a digital nerve and a lumbrical muscle. As the branches run along the sides of the fingers their relationship to the nerves is

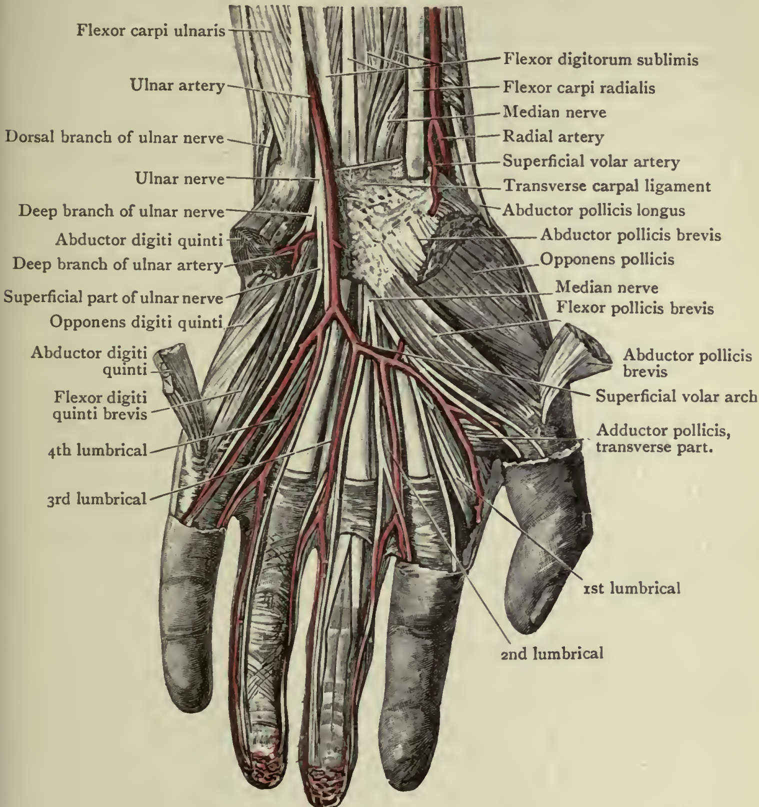


FIG. 69.—The parts in the Palm which are displayed by the removal of the Palmar Aponeurosis. In the specimen from which the drawing was taken the arteria volaris indicis radialis and the arteria princeps pollicis took origin from the superficial volar arch.

changed; the nerves become superficial or volar and the arteries lie behind the nerves. Opposite the terminal phalanx the two arteries of each finger join to form an arch from which a great number of fine branches are distributed to the pulp of the finger and to the bed upon which the nail rests.

At the cleft of the finger immediately before it divides, each digital artery is joined by the corresponding volar metacarpal artery from the deep volar arch; and, as the branches run along the sides of the fingers, they give off numerous twigs to supply the skin, the flexor tendons and the joints of the fingers.

The superficial volar arch is not uncommonly absent in whole or in part. In such cases the digital arteries are replaced by the volar metacarpal branches of the deep volar arch.

Nervus Medianus.—The median nerve was traced to the proximal border of the transverse carpal ligament when the front of the forearm was dissected. As it passes from the forearm to the palm of the hand it lies behind the transverse carpal ligament at the lateral margin of the tendons of the flexor digitorum sublimis (Fig. 60) and in close relation with the mucous sheath which surrounds those tendons. Near the distal border of the transverse carpal ligament it is first flattened antero-posteriorly and then it divides into a smaller lateral, and a larger medial division. The *lateral division* gives off a branch which supplies the short abductor, the opponens and the short flexor of the thumb; then it divides into three digital branches, of which two go to the sides of the thumb and the third to the radial side of the index finger. The digital branches supply the skin, tendons, ligaments and joints of the regions to which they are distributed. In addition the branches to the medial side of the thumb and the radial side of the index digit give branches to the fold of integument which stretches between the roots of those digits, and the nerve to the index finger also gives a branch to the first lumbrical muscle.

The larger medial division divides into two branches. One runs towards the cleft between the index and middle fingers and divides to supply the adjacent sides of those fingers; before it divides it gives a muscular branch to the second lumbrical muscle. The second branch of the medial division divides, in a similar manner, to supply the adjacent sides of the middle and ring digits, but before it divides it gives a communicating twig to the lateral branch of the superficial division of the ulnar nerve. It sometimes gives a muscular branch to the third lumbrical muscle. In the palm the digital branches of the median nerve pass distally deep to the superficial volar arch and its digital branches, but as they approach the fingers they become superficial to the digital arteries. Further, it should be noted that those branches of the median nerve which supply the adjacent sides of fingers divide at a more proximal level than that at which the digital arteries divide.

As they run along the sides of the fingers the digital nerves send branches to the skin of the whole of the volar aspect, and to the skin of the dorsal aspects of the second and third phalanges. At the extremity of the finger each nerve of supply divides into two branches. One of the two ramifies in the pulp of the finger and the other passes dorsally to the bed of the nail.

If the dissector exercises sufficient care in the dissection of the branches of the digital nerves he will find minute oval, seed-like bodies attached to the smaller twigs. They are special sensory end organs called *Pacinian Bodies.*

It follows, from what has already been pointed out, that, in the region of the hand, the median nerve supplies five muscles and the skin of three and a half digits. The muscles are the abductor pollicis brevis, the opponens pollicis, the superficial head of the flexor pollicis brevis and the two most lateral lumbrical muscles; the digits are the pollex, the index, the medius and the radial half of the annularis.

Nervus Ulnaris.—The palmar continuation of the ulnar nerve enters the palm by passing *superficial to* the transverse carpal ligament. As it lies secure from the effects of pressure, under the shelter of the pisiform bone and upon the medial side of the ulnar artery, it divides into two terminal branches —a superficial and a deep.

The *deep branch* passes to the medial side of the hook of the os hamatum and then dips, deeply, into the palm, with the deep branch of the ulnar artery, through the cleft between the abductor digiti quinti and the flexor digiti quinti brevis. It supplies the short muscles of the little finger as it passes between them, and afterwards gives branches to numerous other muscles. Its further course and distribution will be seen when the deep part of the palm is dissected (p. 170).

The *superficial branch* passes distally, under cover of the palmaris brevis, to which it gives a twig of supply. Whilst under cover of the palmaris brevis it divides into two digital branches. The medial of the two branches passes to the medial side of the little finger. The lateral branch pierces the septum which passes dorsally from the medial border of the intermediate part of the palmar aponeurosis, and enters the intermediate compartment of the palm. There it is joined by a communicating branch from the first medial digital branch of the median nerve, and then it divides into two branches which supply the adjacent sides of the ring and little fingers.

Dissection.—After the branches of the median and ulnar nerves have been examined, remove the lateral part of the palmar aponeurosis from the muscles of the thenar eminence, but preserve their nerve of supply, which has already been found. As soon as the aponeurosis is removed two muscles are exposed; they are the abductor pollicis brevis and the superficial head of the flexor pollicis brevis. The abductor is the lateral muscle; pass the handle of the scapel behind its lateral border and lift the muscle from the subjacent opponens pollicis, then divide the abductor about the middle of its length; turn the proximal part towards its origin, and the distal part towards its insertion. When that has been done the opponens will be exposed, and must be cleaned. Next divide the short flexor at its middle and reflect it towards its extremities. The reflection of the short flexor will bring into view parts of the adductor of the thumb, emerging from behind the flexor tendons of the fingers, and along the medial border of the opponens pollicis the tendon of the flexor pollicis longus will be seen; it is enclosed in its mucous sheath, which should not be injured.

At this stage the mucous sheaths of the flexor tendons may be re-examined (see p. 134) by inflation or with the aid of a blunt probe.

Note that the common sheath which envelops the tendons of the flexor digitorum sublimis and the flexor digitorum profundus extends, from the distal part of the forearm, behind the transverse carpal ligament, to the middle of the palm. Its proximal limit is about 25 mm. above the transverse ligament. At its distal limit, which is at the middle of the palm, practically at the same level as the most distal part of the superficial volar arch, it terminates, opposite the index, middle and ring fingers, in blunt protusions on the tendons of the corresponding fingers, but on its ulnar side it is prolonged into and is continuous with the flexor digital sheath of the little finger, which is prolonged to the base of the terminal phalanx of the little finger (Fig. 58). The continuity is easily demonstrated, if inflation fails, by making a small incision into the flexor sheath of the little finger and passing a probe through the incision and along the sheath.

The synovial sheath of the flexor pollicis longus reaches the same proximal level as the common flexor sheath, and it is prolonged, distally, to the base of the terminal phalanx of the thumb. The extent of this sheath can be investigated by a blunt probe introduced through a small opening made opposite the first phalanx of the thumb.

In some cases the mucous sheath which ensheaths the flexor tendons of the fingers is divided into a medial and a lateral compartment by a fibrous septum, and the lateral compartment may communicate with the sheath of the flexor pollicis longus by means of a small aperture situated at the proximal margin of the transverse carpal ligament.

Ligamentum Carpi Transversum (O.T. Anterior Annular Ligament).—The transverse carpal ligament should now be

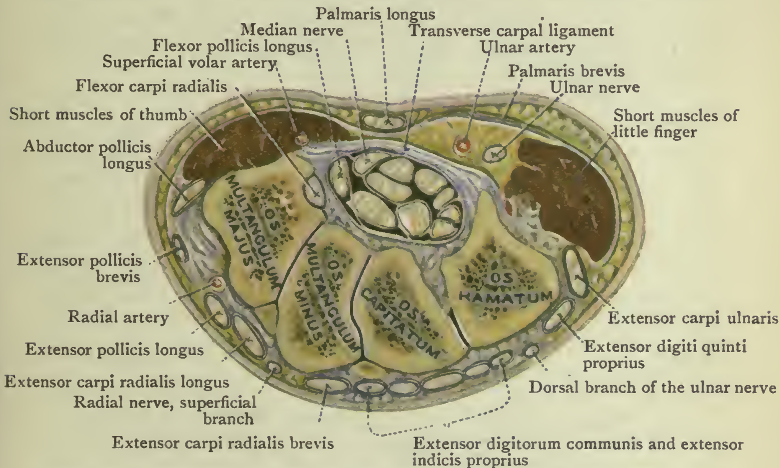


FIG. 70.—Transverse section through the Wrist at the level of the Distal Row of Carpal Bones to show the Carpal Tunnel. The Tendons of the Flexor Digitorum Sublimis, Flexor Digitorum Profundus, and Flexor Pollicis Longus are seen within the Tunnel.

thoroughly examined before it is divided to expose the portions of the flexor tendons, which lie behind it. It is a thick, dense, fibrous band, which stretches across the volar aspect of the concavity of the carpus, and converts it into an osteo-fibrous tunnel for the passage of the flexor tendons into the palm. On each side it is attached to the piers of the carpal arch, viz., on the *lateral side* to the tubercle of the navicular bone and the ridge of the greater multangular bone, and on the *medial side* to the pisiform bone and the hook of the os hamatum. Its proximal margin is continuous with the deep fascia of the forearm, of which it may be considered to be a thickened part; whilst distally it is connected with the palmar aponeurosis.

Upon the volar surface of the transverse carpal ligament the expanded tendon of the palmaris longus is prolonged distally to the intermediate part of the palmar aponeurosis, whilst from its sides some of the short muscles of the thumb and little finger take origin. Close to its medial attachment the ulnar artery and nerve find their way into the palm by passing superficial to it and deep to a more superficial fascial band, the *volar carpal ligament*, which is attached on the medial side to the pisiform and the hook of the os hamatum, and on the lateral side to the volar surface of the transverse carpal ligament.

The tunnel which the transverse carpal ligament forms with the volar concavity of the carpus is transversely oval in shape, and it opens distally into the intermediate compartment of the palm. Through it pass the tendons of the flexor digitorum sublimis, the flexor digitorum profundus, the tendon of the flexor pollicis longus and the median nerve. The relation of the tendon of the flexor carpi radialis to the transverse carpal ligament is peculiar. It pierces the lateral attachment of the ligament, and proceeds distally, in the groove of the os multangulum majus, in a special compartment provided with a special mucous sheath.

***Dissection.*—Clean the fibrous sheaths of the flexor tendons of the fingers and the thumb. They lie immediately subjacent to the superficial fascia and the digital vessels and nerves, and they bind the tendons to the volar aspects of the phalanges and the interphalangeal joints.**

Flexor Sheaths.—Immediately subjacent to the skin, the superficial fascia and the volar digital arteries and nerves, lie the fibrous sheaths which bind the flexor tendons to the volar surfaces of the phalanges, and to the volar accessory ligaments of the metacarpo-phalangeal and interphalangeal joints. Each fibrous sheath consists of a number of parts of which the two strongest, the *digital vaginal ligaments*, lie opposite the bodies of, and are attached to the margins of, the first and second phalanges. Such strong bands placed opposite the metacarpo-phalangeal and interphalangeal joints would seriously interfere with their movements; therefore, in those regions, weaker transverse bands, the *annular ligaments*, are formed. In addition, cruciate bands—the *cruciate* *ligaments*—are often found intervening between the annular ligaments and the stronger portions of the sheaths. The

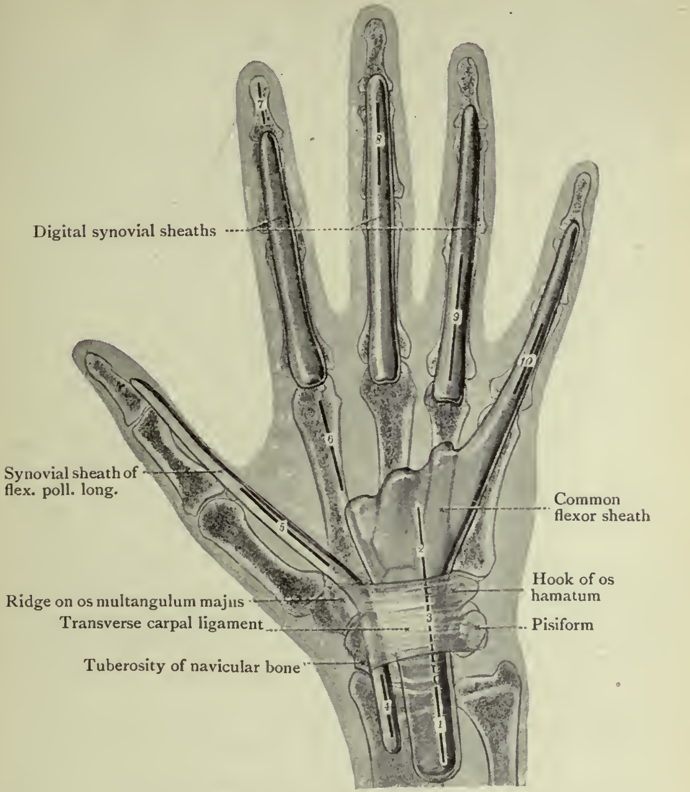


FIG. 71.—The Synovial Sheaths of the Wrist and Hand. The positions of various incisions for the evacuation of pus are also shown.

1 and 2. Incisions into the common palmar sheath, placed between the median and ulnar nerves.
3. Incision uniting 1 and 2.
4. Incision into the proximal part of the sheath of flexor pollicis longus. It is placed between the radial artery and the median nerve.
5. Incision into the distal part of the sheath of flexor pollicis longus.
6. Incision into the thenar space.
7. Incision over terminal phalanx.
8, 9 and 10. Incisions into the digital sheaths. They lie opposite the shafts of the phalanges.

fibrous sheath, together with the phalanges and the volar accessory ligaments of the metacarpo-phalangeal and interphalangeal joints, forms, in each finger, an osteo-fibrous canal, in which are enclosed the tendons of the flexor digitorum sublimis and the flexor digitorum profundus together with their surrounding mucous sheath.

Leave the fibrous sheath of the middle finger intact for revision, but open the other fibrous sheaths by longitudinal incisions. They will be seen to be lined with a mucous sheath which is reflected over the enclosed tendons so as to give each a separate investment. Examine the extent of each mucous sheath with the aid of a blunt probe. The mucous sheath of the little finger has been seen to be a direct prolongation from the common mucous sheath of the flexor tendons; the other three are distinct from that, but they are carried proximally into the palm. They envelop the tendons of the ring, index and middle fingers, as far as a line drawn across the palm immediately proximal to the heads of the metacarpal bones.

If the flexor tendons are raised from the phalanges, certain mucous folds will be noticed connecting them to the bones. These are termed the *vincula tendinum*. Two kinds of them are distinguished, viz., vincula brevia and longa. In the accompanying illustration (Fig. 72) the connections of these may be seen. The *vincula brevia* are triangular folds which connect the tendons, near their insertions, to the volar aspect of the more proximal phalanx. The *vincula longa* are not invariably present. They are placed more proximally, and are narrow, weak strands which pass between the tendons and the bones.

Insertions of the Flexor Tendons.—The insertions of the two flexor tendons can now be studied. On the volar side of the first phalanx the tendon of the flexor sublimis becomes flattened and folded round the subjacent cylindrical tendon of the flexor profundus. It then splits into two parts, which pass dorsal to the tendon of the flexor profundus, and allow the latter to proceed onwards between them. Dorsal to the deep tendon the two portions of the tendon of the flexor sublimis fuse together, and then, again, they diverge, to be inserted into the borders of the body of the second phalanx. By this arrangement the flattened tendon of the flexor sublimis forms a ring, or short tubular passage, through which the tendon of the flexor profundus proceeds onwards to the base of the ungual phalanx, into which it is inserted. In each of the four fingers the same arrangement is found; the tendon of the flexor sublimis is inserted by two slips into the margins of the volar surface of the second phalanx, whilst the tendon of the flexor profundus is inserted into the volar aspect of the base of the terminal phalanx.

Dissection.—Open the carpal tunnel by making a vertical incision through the middle of the transverse carpal ligament. Clean the mucous sheaths from the flexor tendons, and separate the tendons from one another, but be careful not to injure the lumbrical muscles which spring from the tendons of the flexor digitorum profundus. Be careful also not to injure the nerves

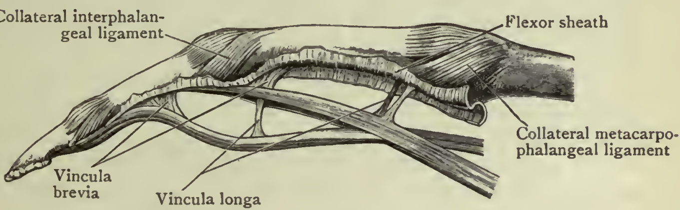


FIG. 72.—Flexor Tendons of the Finger with Vincula tendinum.

of supply from the lateral two lumbricals. They are twigs from the digital branches of the median nerve, and have already been found. The nerves to the medial two lumbricals are from the deep division of the ulnar nerve. They will be found at a later stage of the dissection. Clean the lumbrical muscles and then examine the arrangement of the flexor tendons and the origins and insertions of the lumbrical muscles.

Flexor Tendons.—The four tendons of the *flexor sublimis* are arranged in pairs deep to the transverse carpal ligament; those for the little and the index fingers lie dorsal to those for the ring and middle fingers. Of the tendons of the *flexor profundus*, only that for the index finger is distinct and separate; the other three, as a rule, remain united until they emerge from under cover of the distal border of the transverse carpal ligament.

In the intermediate compartment of the palm the flexor tendons diverge from each other, and two, viz., one from the flexor sublimis, and one from the flexor profundus, go to each of the four fingers. From the tendons of the flexor profundus the lumbrical muscles take origin, and those muscles, and the volar digital nerves and arteries, will be seen occupying the intervals between the tendons as they approach the roots of the fingers.

In the *fingers* the two flexor tendons run distally, upon the volar aspects of the phalanges, and are held in position by the flexor sheaths, which have already been studied.

The tendon of the *flexor pollicis longus* occupies the lateral part of the tunnel, and, gaining the palm, turns laterally to reach the terminal phalanx of the thumb.

Tendon of the Flexor Pollicis Longus.—The tendon of the long flexor of the thumb proceeds distally, in the interval between two of the short muscles of the thumb (viz., the superficial head of the flexor pollicis brevis and the oblique part of the adductor pollicis), and also in the interval between the two sesamoid bones which play upon the head of the metacarpal bone. At the base of the proximal phalanx it enters a fibrous flexor sheath constructed upon a similar plan to those of the fingers, and passes along it to the base of the terminal phalanx, into which it is inserted. The mucous sheath which surrounds the tendon during its passage through the carpal tunnel is continuous with the sheath which invests the tendon in front of the phalanges.

Mm. Lumbricales.—The lumbrical muscles are four slender fleshy bellies which arise from the tendons of the flexor digitorum profundus as they traverse the palm. The *first lumbrical* arises from the lateral side of the tendon for the index finger; the *second lumbrical* springs from the lateral border of the tendon for the middle finger; whilst the *third* and *fourth lumbricals* take origin from the adjacent sides of the tendons between which they lie (viz., the tendons for the middle, ring, and little fingers). The little muscles pass distally, and end in delicate tendons on the lateral sides of the fingers. Each tendon is inserted into the lateral margin of the expansion of the extensor tendon, which lies upon the dorsal aspect of the proximal phalanx.

Dissection.—Divide the flexor digitorum profundus in the forearm, and turn the distal part towards the fingers. As the tendons and the lumbrical muscles which are attached to them are raised, secure the fine twigs of supply which pass to the medial two lumbricals from the deep division of the ulnar nerve. They are easily found if ordinary caution is observed. The deep volar arch and the deep division of the ulnar nerve are now exposed. Clean both the arch and the nerve, and trace the branches of the nerve to the interossei muscles and to the adductor pollicis and the deep head of the flexor pollicis brevis. Then

examine the relations of the deep volar arch, and the deep division of the ulnar nerve.

Arcus Volaris Profundus (O.T. **Deep Palmar Arch**).—Two arteries take part in the formation of the deep volar arch, the radial and the profunda branch of the ulnar. The radial, which plays the chief part, enters the palm through the proximal end of the first interosseous space, between the two heads of the first dorsal interosseous muscle, and in the present stage of dissection it is seen appearing through the cleft between the oblique and transverse parts of the adductor pollicis. The arterial arcade formed by its union with the profunda branch of the ulnar artery lies across the metacarpal bones, immediately distal to their bases, and across the interosseous muscles in the intervening interosseous spaces. The deep arch is, therefore, about a finger's breadth proximal to the superficial volar arch, but it is in a much deeper plane, for it is separated from the superficial volar arch by the flexor tendons of the fingers and their mucous sheath, the lumbrical muscles, branches of the median nerve and the flexor digiti quinti brevis. The convexity of the deep arch, which is less marked than that of the superficial arch, is directed towards the fingers, and in its concavity lies the deep branch of the ulnar nerve.

The *branches* which spring from the deep volar arch are: (1) the *recurrent*—a few small twigs which run proximally, in front of the carpus, to anastomose with branches of the volar carpal arch; (2) *perforating branches*, which pass dorsally in the proximal parts of the interosseous spaces to anastomose with the dorsal metacarpal arteries; and (3) the *volar metacarpal branches*—three in number—which pass distally, volar to the interosseous spaces, and unite, near the roots of the fingers, with the corresponding volar digital arteries from the superficial volar arch. Sometimes the volar metacarpal branches are large and take the place of the corresponding volar digital arteries.

Ramus Profundus Nervi Ulnaris.—The deep branch of the ulnar nerve springs from the parent trunk on the volar aspect of the transverse carpal ligament, and gives off a branch which supplies the three short muscles of the little finger. Accompanied by the deep branch of the ulnar artery, it sinks into the interval between the abductor and flexor digiti quinti brevis, and turns laterally across the palm, deep to the flexor tendons. Near the lateral border of the palm the deep branch of the ulnar nerve breaks up into terminal twigs which supply the adductor pollicis and the first dorsal interosseous muscle. In its course across the palm it lies along the concavity or proximal border of the deep volar arch, and sends three fine branches distally in front of the three interosseous spaces. They supply the interosseous muscles in the spaces, while the medial two give branches

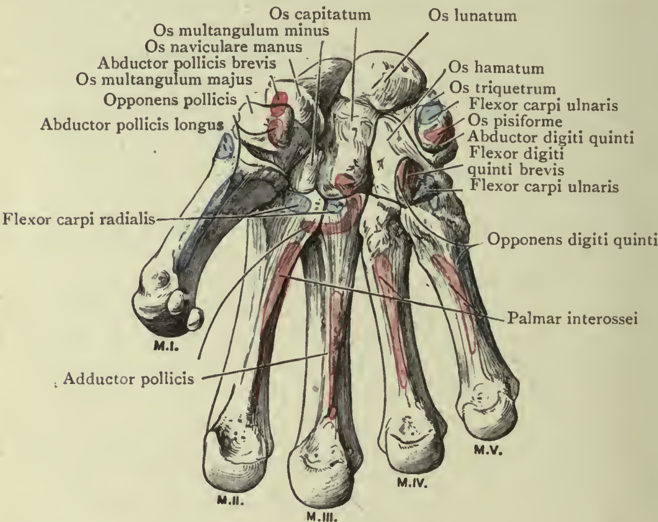


FIG. 73.—Volar aspect of the Bones of the Carpus and Metacarpus with Muscular Attachments mapped out.

also to the medial two lumbrical muscles. The third lumbrical has frequently a double nerve supply; it receives a branch from the deep part of the ulnar nerve, and, not uncommonly, a second twig from the median nerve enters its volar aspect.

The deep branch of the ulnar nerve may, therefore, be said to supply all the muscles of the palm which lie to the medial side of the tendon of the flexor pollicis longus, whilst the median nerve supplies the three muscles which lie to the lateral side of that tendon. There are two exceptions to this generalisation, viz., the lateral two lumbrical muscles, which lie upon the medial side of the tendon, and are yet supplied by the median nerve.

> ***Dissection.***—**Clean the adductor of the thumb and then examine the short muscles of the thumb and revise the short muscles of the little finger.**

The Short Muscles of the Thumb.—Three of the short muscles of the thumb have already been dissected. All four are now displayed, with the exception of the deep head of the short flexor, which cannot be seen until the adductor has been reflected. Their relations and attachments should now be studied. Three of the four, the abductor pollicis brevis, the superficial head of the flexor pollicis brevis and the opponens pollicis lie on the lateral side of the tendon of the flexor pollicis longus; the fourth muscle, the adductor pollicis, is on the medial side of that tendon.

The *abductor pollicis brevis* forms the most prominent and lateral part of the ball of the thumb. The *superficial head of the flexor pollicis brevis* is immediately medial to the abductor; the *opponens* is deep to both of them and is exposed when they are pulled apart, or when they are reflected. The fan-shaped *adductor pollicis* lies deeply in the palm. It is imperfectly separated into a proximal or oblique portion and a distal or transverse portion. The separation is produced by the radial artery as it enters the palm through the first interosseous space. The deep head of the flexor pollicis brevis is concealed by the adductor, and cannot be seen at this stage of the dissection.

The branch of the median nerve which supplies the three muscles which lie lateral to the tendon of the flexor pollicis longus has already been found (p. 155), and the twigs to the adductor which are derived from the deep branch of the ulnar nerve have also been traced (p. 166).

M. Abductor Pollicis Brevis.—The short abductor of the thumb arises from the volar aspect of the transverse carpal ligament and from the ridge on the os multangulum majus. It is inserted into the lateral sesamoid bone of the thumb, into the lateral side of the base of the first phalanx, and to a slight extent into the extensor tendon on the dorsum of the first phalanx. It is supplied by the *median nerve.*

M. Flexor Pollicis Brevis (Caput Superficialis).—The superficial head of the short flexor of the thumb takes origin from the transverse carpal ligament. It is inserted into the lateral sesamoid bone of the thumb, and into the lateral side of the proximal phalanx, and it is supplied by the *median nerve*. (For the deep head see below.)

M. Opponens Pollicis.—The opponens muscle of the thumb springs from the transverse carpal ligament and the ridge on the volar surface of the os multangulum majus. Its fibres spread out as they approach their insertion into the whole length of the radial border and the adjacent part of the volar surface of the metacarpal bone of the thumb. It is supplied by the *median nerve*.

M. Adductor Pollicis.—The adductor of the thumb consists of an oblique and a transverse part. The oblique part arises from the os capitatum, and the bases of the second and third metacarpal bones (Fig. 73). In some cases it has a slip of origin from the os multangulum minus. The transverse part springs from the distal two-thirds of the volar border of the third metacarpal bone. The two parts converge as they pass to their insertion into the medial sesamoid bone of the thumb and the medial side of its proximal phalanx. In many cases a slip of muscle fibres leaves the lateral side of the oblique part of the adductor, passes dorsal to the tendon of the flexor pollicis longus, and fuses with the superficial head of the flexor pollicis brevis. Both parts of the muscle are supplied by twigs from the deep division of the *ulnar nerve*.

At this stage of the dissection the short muscles of the little finger, the abductor, the short flexor and the opponens, should be revised (see p. 152).

Dissection.—To display the branches of the palmar parts of the radial artery and the deep head of the flexor pollicis brevis, cut through the two parts of the adductor pollicis midway between their origins and insertions, and turn the separated portions aside. The deep head of the flexor pollicis brevis lies along the ulnar border of the metacarpal bone of the thumb, and the radial artery will be found entering the palm between the two heads of the first dorsal interosseous muscle at the proximal end of the first interosseous space. Its last two branches, the princeps pollicis and the volar radial artery of the index finger, spring from it as soon as it enters the palm, and whilst it still lies behind the oblique part of the adductor pollicis.

The Deep Head of the Flexor Pollicis Brevis.—This weak slip of muscle lies along the medial side of the metacarpal bone of the thumb between the radial head of the first dorsal interosseous muscle and the adductor pollicis. It arises from the ulnar side of the base of the first metacarpal bone and is inserted into the ulnar side of the base of the first phalanx of the thumb. It is supplied by a twig from the deep division of the ulnar nerve.

Arteria Volaris Indicis Radialis, et Arteria Princeps Pollicis (O.T. Radialis Indicis and Princeps Pollicis Arteries).—These arteries spring from the radial, as it enters the palm, between the first and second metacarpal bones.

The *volar radial artery of the index digit* runs distally between the transverse part of the adductor pollicis and the first dorsal interosseous muscle to the lateral border of the index, along which it proceeds as its lateral volar digital artery.

The *princeps pollicis artery* takes a course distally and laterally, under cover of the oblique part of the adductor pollicis, and gains the volar aspect of the metacarpal bone of the thumb. There it lies dorsal to the tendon of the flexor pollicis longus, and divides into two terminal branches, one for each side of the free part of the thumb. The branches make their appearance in the interval between the adductor and the superficial head of the flexor pollicis brevis, and run distally, one on each side of the tendon of the long flexor.

Surgical Anatomy of the Palm and Fingers.—When an abscess forms in the intermediate compartment of the palm early surgical interference is urgently called for. The dense palmar aponeurosis effectually prevents the passage of the pus to the surface of the palm, whilst an easy route proximally, into the forearm, is offered to it by the open carpal tunnel, through which the flexor tendons enter the palm. It is necessary, therefore, that before this can occur the surgeon should make an opening in the palm by means of which the pus can escape.

In making such an incision it is important to bear in mind the position of the various vessels which occupy the intermediate compartment of the palm. As previously stated, the level of the superficial volar arch can be indicated by drawing a line transversely across the palm from the distal margin of the outstretched thumb. The deep volar arch lies half an inch more proximally. The volar digital arteries, which spring from the convexity of the superficial volar arch, run in line with the clefts between the fingers. An incision, therefore, which is made distal to the superficial volar arch and in a direction corresponding to the central line of one of the fingers, may be considered free from danger in so far as the vessels are concerned.

The loose mucous sheath which envelops the flexor tendons as they pass deep to the transverse carpal ligament has been seen to extend proximally into the distal part of the forearm, and distally into the palm. When the sheath is attacked by inflammatory action it is apt to become distended with fluid (thecal ganglion), and the anatomical arrangement of the parts at once offers an explanation of the appearance which is presented. There is a bulging in the palm, and a bulging in the distal part of the forearm, but no swelling at all at the wrist. There the dense transverse carpal ligament resists the expansion of the mucous sheath, and an hour-glass constriction is evident at that level. The lines along which incisions should be made into the volar compartments of the palm and the mucous sheaths of the flexor tendon are shown in Fig. 71.

The fingers are subject to an inflammatory process, termed *whitlow*, and, in connection with this, it is essential to remember that the flexor fibrous sheath ends on the base of the distal phalanx in each digit. When the whitlow occurs more distally, in the pulp of the finger, the vitality of the distal part of the ungual phalanx is endangered, but the flexor tendons may be regarded as being tolerably safe. When the inflammation occurs more proximally, and involves the flexor sheath, as it generally does, sloughing of the tendons is to be apprehended, unless an immediate opening is made. No slight superficial incision will suffice. The knife must be carried deep into the centre of the finger, so as to freely lay open the sheath containing the tendons. Early interference in cases of whitlow of the thumb and little finger is even more urgently required than in the case of the other three digits, because the digital mucous sheaths of the former are, as a rule, connected with the great common mucous sheath of the flexor tendons, and so offer a ready means for the proximal extension of the inflammatory action.

Every amputation of the fingers proximal to the insertion of the tendons of the flexor profundus involves the opening of the flexor sheaths, and no doubt explains the occasional occurrence of palmar trouble after operations of that kind. The open tubes offer a ready passage by means of which septic material may travel proximally into the palm, and, in the case of the thumb and little finger, into the carpal tunnel and distal part of the forearm.

Dorsum and Lateral Border of the Forearm.

The structures which still remain to be dissected in this region are:—

1. The supinator and extensor muscles.
2. The dorsal interosseous artery.
3. The perforating or terminal branch of the volar interosseous artery.
4. The dorsal interosseous nerve.

Before the dissection is proceeded with, the cutaneous veins and nerves and the deep fascia, previously displayed, should be re-examined. The two main cutaneous veins are seen. Both ascend from the venous plexus on the dorsum of the hand, and both turn round a border of the forearm to gain its volar surface, but whilst the cephalic vein turns round the distal third of the radial border, the basilic ascends to a much more proximal level before it turns round the ulnar border.

The cutaneous nerves are four in number:—(1) The dorsal branch of the lateral cutaneous nerve of the forearm, on the lateral side; (2) the dorsal branch of the medial cutaneous nerve of the forearm on the medial side; (3) in the intermediate area the distal branch of the dorsal cutaneous nerve of the forearm; (4) the superficial division of the radial nerve appearing from under cover of the brachio-radialis about 8 cm. ($3\frac{1}{4}$ inches) proximal to the wrist. Thus three of the terminal branches of the brachial plexus are represented on the dorsum of the forearm—the musculo-cutaneous nerve by the lateral cutaneous nerve of the forearm; the medial cutaneous nerve of the forearm; and the radial nerve by its superficial division, and by the dorsal cutaneous nerve of the forearm.

In the dorsum of the hand the distribution of the superficial branch of the radial nerve and the dorsal branch of the ulnar nerve have already been examined (pp. 71, 72); the radial nerve supplies the greater part of the skin of the dorsum of the hand and three and a half digits—the thumb, and the proximal parts of the index, the middle, and half the ring fingers—whilst the dorsal branch of the ulnar nerve supplies the remaining half of the ring finger and the little finger. The skin of the distal parts of the index, the middle, and half the ring fingers is supplied, as already noted (p. 159), by twigs of the digital branches of the median nerve.

Dissection.—**Remove the cutaneous vessels and nerves from the dorsum of the forearm and hand, then revise the deep fascia.**

The Deep Fascia.—The deep fascia of the dorsum of the forearm is stronger than the deep fascia of the volar aspect. Its proximal part is strengthened by expansion from the triceps, and near the elbow it is intimately connected with the muscles of the back of the forearm which take part of their origin from its deep surface. It is closely attached to the whole length of the dorsal border of the ulna, and in the regions of the distal ends of the radius and ulna and the back of the carpus it is thickened by numerous transverse fibres which constitute the ligamentum carpi dorsale.

Dissection.—**The dorsal carpal ligament must be left *in situ* until the dissection of the dorsal parts of the forearm and hand is completed. To secure its retention in an uninjured condition, isolate it by cutting carefully through the deep fascia parallel with its proximal border. Whilst making the incision, care must be taken to avoid injury to the mucous sheaths of the extensor tendons which lie immediately subjacent to the deep fascia. When the front of the forearm was dissected, the radial flap of deep fascia was reflected only as far as the radial border of the**

forearm. Now continue the reflection until the attachment of the flap to the posterior border of the ulna is reached. As the reflection proceeds, the intermuscular septa which pass from the deep surface of the deep fascia between the muscles of the dorsum of the forearm must be divided.

Superficial Muscles.—The muscles in this region consist of a superficial and a deep group. The *superficial muscles*, named from the lateral to the medial border of the forearm, are:—(1) the brachio-radialis; (2) the extensor carpi radialis longus; (3) the extensor carpi radialis brevis; (4) the extensor digitorum communis; (5) the extensor digiti quinti proprius; (6) the extensor carpi ulnaris; and (7) the anconæus. This group therefore comprises one flexor of the elbow, three extensors of the wrist, two extensors of the fingers, and a feeble extensor of the forearm at the elbow joint, viz., the anconæus. In the distal part of the forearm the extensor digitorum communis is separated from the extensor carpi radialis brevis by a narrow interval, in which appear two muscles belonging to the deep group. The two muscles in question turn round the lateral margin of the forearm, superficial to the radial extensors of the wrist, and end in tendons which go to the thumb. The proximal of the two muscles is the abductor pollicis longus, the distal is the extensor pollicis brevis, but they lie in such close contact, and so intimately are their tendons connected, that in many cases they appear, at first sight, to be blended together by their margins. After they have become superficial, the abductor pollicis longus and the extensor pollicis brevis turn round the radial border of the forearm superficial to the radial extensors of the wrist, and as they descend to the thumb they lie in the groove on the lateral surface of the styloid process of the radius in which they are retained by the most lateral part of the dorsal carpal ligament (Fig. 74).

A short distance proximal to the dorsal carpal ligament on the radial side of the tendons of the extensor digitorum a third muscle of the deep group also comes into view; it is the extensor pollicis longus. Its tendon crosses the radial extensors of the wrist at the distal border of the dorsal carpal ligament.

Dissection.**—The skin of the dorsum of the hand has already been removed, and the cutaneous nerves and veins have been displayed. The thin deep fascia is still in position, but it will not prevent a successful demonstration of the mucous sheaths**

PLATE X

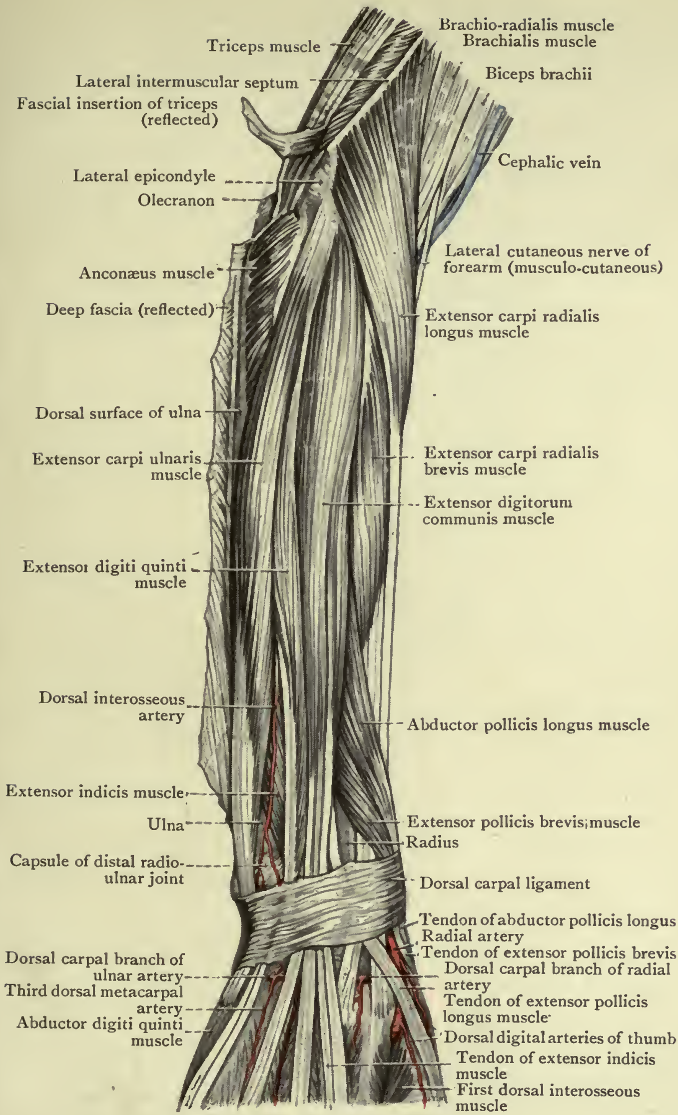


FIG. 74.—Dissection of the Dorsal Aspect of the Forearm.

of the extensor tendons, which should be attempted before the superficial extensor muscles are cleaned. Introduce a blow-pipe into each mucous sheath immediately proximal to the

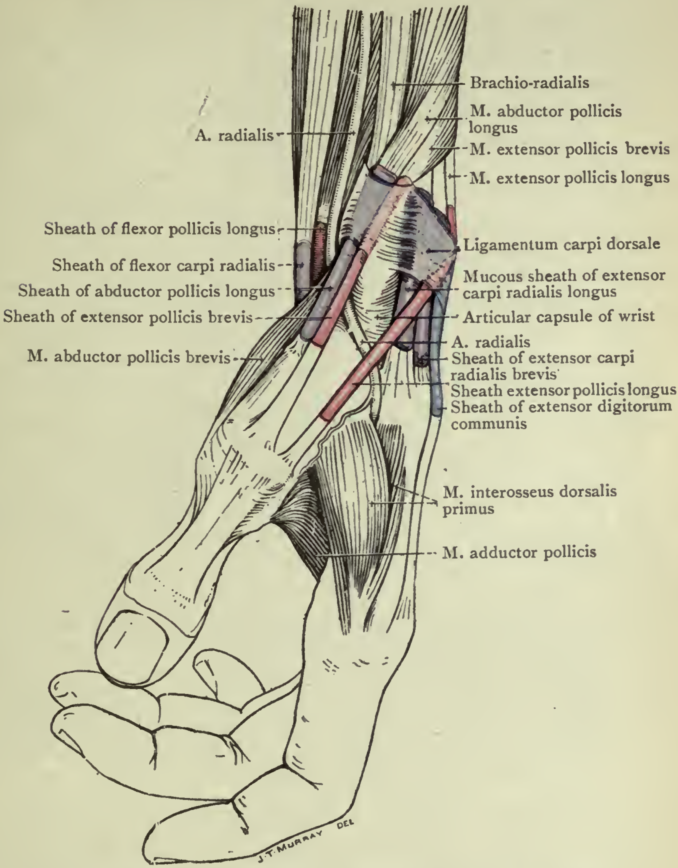


FIG. 75.—Dissection of the Lateral Side of the Left Wrist and Hand showing Mucous Sheaths of Tendons.

dorsal carpal ligament and then inflate the sheath. Commence with the sheath of the abductor pollicis longus and the extensor pollicis brevis; then inflate in succession the sheaths of the radial extensors of the wrist, the common extensor ot the fingers, the extensor digiti quinti, and the extensor carpi ulnaris. A better demonstration of the mucous sheaths may be made by

injecting them, by means of a large hypodermic syringe, with a thin solution of coloured starch. If the sheaths have been injured, and it is not possible to distend them, then open each and examine its extent with the aid of a blunt probe.

The Mucous Sheaths of the Extensor Tendons.—Seven mucous sheaths surround the tendons which pass under cover of the dorsal carpal ligament. Two lie along the distal part of the radial border of the forearm; they are the sheaths of the abductor pollicis longus and the extensor pollicis brevis. They may communicate with one another. From the radial to the ulnar border the remaining five sheaths are arranged in the following order: the sheath of the extensor carpi radialis longus, the sheath of the extensor carpi radialis brevis, a sheath common to the extensor digitorum communis and the extensor indicis, the sheath of the extensor digiti quinti, and the sheath of the extensor carpi ulnaris.

The proximal limit of the sheaths lies at, or slightly proximal to, the dorsal carpal ligament. The sheaths of the abductor pollicis longus and the radial and ulnar extensors of the carpus are prolonged distally to the insertions of the tendons of these muscles. As regards the sheaths of the extensors of the fingers and thumb, it may be said, speaking generally, that they terminate distally about the level of the mid-length of the hand (Figs. 75, 76).

Dissection.**—The brachio-radialis has already been dissected; the other superficial muscles must now be cleaned and, as far as possible, isolated from one another. The isolation of the distal parts is not difficult, but the proximal parts spring not only from the humerus and the superjacent deep fascia, but also from strong intermuscular septa which intervene between adjacent muscles. To isolate the proximal parts of the muscles, therefore, the dissector must split the intermuscular septa with the scalpel and so isolate each muscle as far as its bony origin.**

M. Brachio-radialis (O.T. Supinator Longus).—The brachio-radialis muscle lies more on the volar than on the dorsal surface of the forearm. It takes origin, in the arm, from the proximal two-thirds of the lateral epicondylar ridge of the humerus and from the lateral intermuscular septum. Near the middle of the forearm a flat tendon emerges from its fleshy belly, and proceeds distally to gain insertion into the lateral aspect of the expanded distal extremity of the radius, at the base of the styloid process. The nerve of supply is a branch of the *radial nerve* (O.T. *musculo-spiral*), which enters the muscle proximal to the elbow. The main action of the muscle is flexion of the elbow, but it can help to initiate supination of the prone forearm and pronation of the supine forearm.

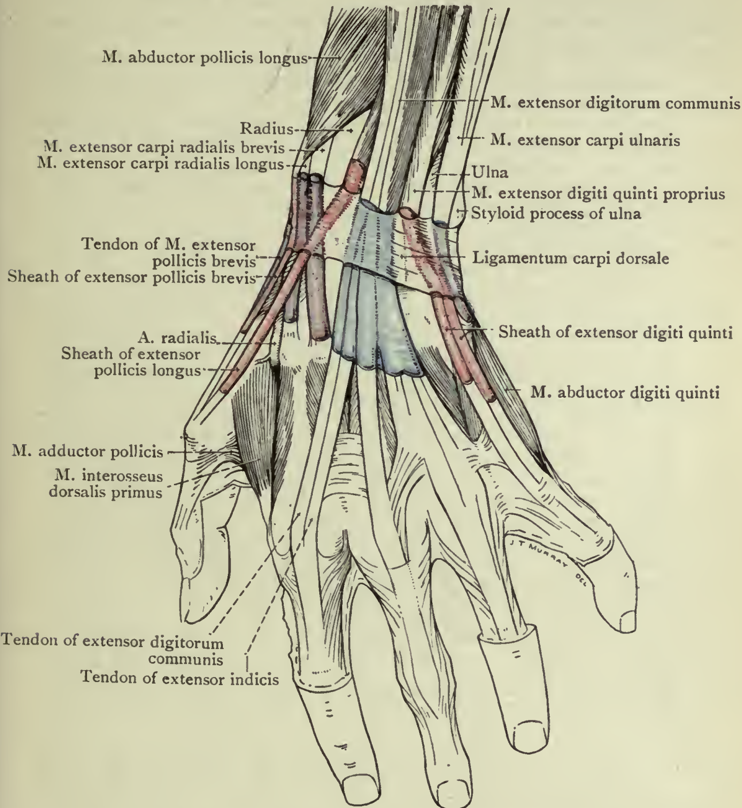


FIG. 76.—Dissection of the Back of the Forearm, Wrist, and Hand, showing Mucous Sheaths of Tendons.

Dissection.—Remove the thin deep fascia of the dorsum of the hand, clear away the mucous sheaths of the tendons and clean the tendons, but do not injure (1) the dorsal carpal ligament, (2) the blood-vessels which lie deep to and in the intervals between the tendons, (3) the slips which connect the tendon to the ring finger with that on each side of it. Three tendons must be followed to the thumb, that of the abductor pollicis longus to the base of the metacarpal bone, that of the extensor pollicis brevis to the base of the first phalanx, and the tendon of the extensor pollicis longus to the base of the terminal phalanx.

There are four tendons of the extensor digitorum communis, one for each finger. Each of the four expands, on the dorsum of the first phalanx of the finger to which it belongs, into an *extensor expansion* which covers the whole of the dorsum of the phalanx.

Near the distal extremity of the first phalanx the extensor expansion divides into three pieces, an intermediate piece and two collateral pieces. The weaker intermediate piece is inserted into the base of the second phalanx. The lateral pieces unite with one another on the dorsum of the second phalanx before they are inserted into the base of the terminal phalanx. Carefully define this arrangement on at least one finger. The tendon of the extensor indicis passes along the ulnar side of the tendon of the extensor digitorum communis to join the extensor expansion of the index finger, and the two tendons of the extensor digiti quinti join the extensor expansion of the little finger.

Clean the margins of the extensor expansion of one or more fingers, and pass the handle of a scalpel between the expansion and the middle of the first phalanx, then note, as the expansion is put on the stretch, that, just beyond the metacarpo-phalangeal joint, the expansion is joined, on each side, by structures which pass to it through the interosseous spaces. On the radial side it is joined by the tendon of a lumbrical muscle and by a slip from the tendon of an interosseous muscle, and, on the ulnar sides, by a slip from a tendon of an interosseous muscle, except in the case of the little finger where there is, of course, no interosseous muscle on the ulnar side. The dissector will have no difficulty in displaying the association ot the lumbrical muscles with the extensor expansions at the present stage of the dissection. The connections of the interossei cannot be properly demonstrated until a later stage.

The Extensor Expansions on the Fingers.—The dissector who has carefully followed the above instructions will have recognised that by means of the extensor expansions a common extensor tendon, a lumbrical, and one or more interossei gain insertion into the dorsal aspects of the bases of the second and terminal phalanges of each finger, and through the same medium the second and terminal phalanges of the index and little fingers are attached to the special extensors of those digits. The dissector should now note the movements he can make with his own fingers: (1) by use of the flexor muscles alone he can flex all three joints of the fingers, the metacarpo-phalangeal, and the proximal and distal interphalangeal joints; (2) by use of the extensor muscles alone he can extend all three joints; (3) by use of the flexors and extensors simultaneously he can flex the interphalangeal and extend the metacarpo-phalangeal joints; (4) he can also flex the metacarpo-phalangeal joints and extend the interphalangeal joints. The last combination of movements is called "putting the fingers in the writing position." It is due mainly to the actions of the lumbricals and interossei, which pass from the volar to the dorsal aspect across the metacarpo-phalangeal joints, and so are enabled to flex those joints, whilst by virtue of their attachments to the extensor expansions they can extend the interphalangeal joints.

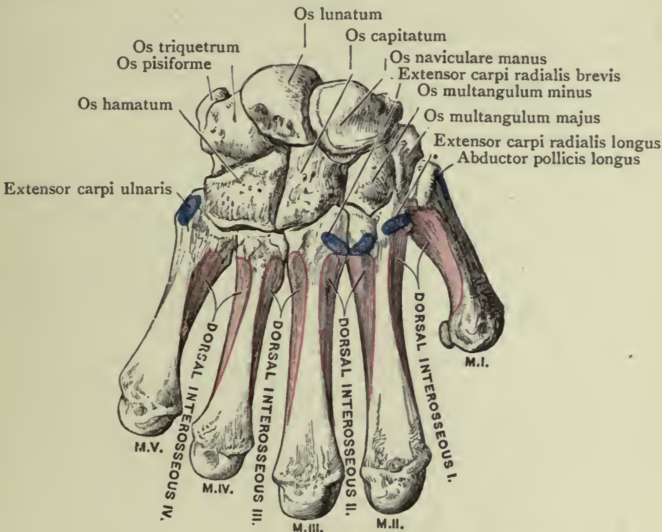


FIG. 77.—Dorsal aspect of the Bones of the Carpus and Metacarpus, with Muscular Attachments mapped out.

M. Extensor Carpi Radialis Longus.—The long radial extensor of the carpus is placed dorsal to the brachio-radialis. It arises from the dista third of the lateral epicondylic ridge of the humerus, and from the lateral intermuscular septum. From the fleshy portion of the muscle a long tendon proceeds, which passes under cover of the dorsal carpal ligament, and is inserted into the dorsal aspect of the base of the metacarpal bone of the index finger. The muscle is supplied by a branch of the trunk of the *radial nerve* (O.T. *musculo-spiral*) which enters it proximal to the elbow. The long radial extensor of the wrist helps to extend and abduct the hand at the wrist-joint, and it assists in flexion of the elbow (Figs. 74, 75, 76).

M. Extensor Carpi Radialis Brevis.—The extensor carpi radialis brevis is closely associated with the preceding muscle. It arises, by the common extensor tendon, from the lateral epicondyle of the humerus; it derives fibres also from the radial collateral ligament of the elbow-joint, from the investing deep fascia, and the fibrous septa in connection with it. The tendon of the muscle accompanies that of the long radial extensor under cover of the dorsal carpal ligament, and is inserted into the dorsal aspect of the base of the third metacarpal bone, immediately beyond the root of its styloid process. This muscle is supplied by the *deep branch of the radial nerve* by a twig given off before the nerve pierces the supinator muscle. It is an extensor of the wrist and the elbow, and an abductor of the hand at the wrist-joint.

M. Extensor Digitorum Communis.—The extensor digitorum communis takes origin, by the common tendon, from the lateral epicondyle of the humerus. The deep fascia and the intermuscular septa in relation to it also contribute fibres. Its fleshy belly, in the distal part of the forearm, ends in four tendons, which pass under cover of the dorsal carpal ligament. On the dorsum of the hand they diverge and proceed onwards to the four fingers. Their arrangement and attachments on the dorsum of the hand and fingers have already been considered (p. 177). The muscle is supplied by the *dorsal interosseous nerve.* It is an extensor of all the joints of the fingers, of the wrist, and of the elbow.

M. Extensor Digiti Quinti Proprius (O.T. **Extensor Minimi Digiti**).—The extensor digiti quinti proprius is a slender fleshy belly which at first sight appears to be a part of the preceding muscle, but its tendon passes through a special compartment in the dorsal carpal ligament. It arises in common with the extensor digitorum communis. Its tendon of insertion splits into two parts. The lateral of the two joins the tendon of the extensor digitorum communis, which passes to the little finger, and the medial part ends in the extensor expansion on the dorsum of the first phalanx of the little finger. The muscle is supplied by the *dorsal interosseous nerve.* It is an extensor of all the joints of the little finger, and it aids in extension of the wrist and elbow.

M. Extensor Carpi Ulnaris.—The extensor carpi ulnaris arises, by means of the common extensor tendon, from the lateral epicondyle of the humerus; from the fascia of the forearm, and from the intermuscular septum between it and the extensor digiti quinti proprius. In the middle third of the forearm it receives some fibres from the strong fascial layer which binds it to the dorsal border of the ulna. The tendon does not become free from the fleshy fibres until it approaches close to the wrist. It occupies the groove on the dorsal aspect of the distal end of the ulna, between the head and styloid process, and, passing under cover of the dorsal carpal ligament, is inserted into the tubercle on the base of the metacarpal bone of the little finger. The muscle is supplied by the *dorsal interosseous nerve*. It is an extensor of the wrist and elbow, and it takes part in the movement of adduction at the wrist, when it acts simultaneously with the flexor carpi ulnaris.

M. Anconæus.—The anconæus lies at the lateral part of the dorsal aspect of the elbow joint. It is a small, short muscle, of triangular outline, which arises, by a relatively small origin, from the back of the lateral epicondyle of the humerus. The insertion is into the lateral border of the olecranon of the ulna and the proximal third of the dorsal surface of the body of the ulna. The nerve of supply has already been dissected. It is a long slender branch which is given off from the trunk of the radial nerve, behind the middle third of the humerus, and it descends through the substance of the medial head of the triceps before it reaches the anconæus. In addition, the distal part of the muscle sometimes receives a branch from the dorsal interosseous nerve. It is an extensor of the elbow joint.

Dissection.—To expose the deep muscles of the back of the forearm and the dorsal interosseous vessels and nerve the extensor digitorum communis and the extensor digiti quinti must be reflected. Divide the fleshy portion of each, about the middle of its length, and turn the proximal parts of the divided muscles towards their origins and the distal parts towards the insertions. As the muscles are reflected care must be taken to secure and preserve the twigs from the dorsal interosseous nerve which enter their deep surfaces. When the reflection is completed pull aside the extensor carpi ulnaris; then the greater parts of the dorsal interosseous vessels and nerve and the deep muscles of the forearm will be exposed. The muscles which are exposed are, from above downwards, the supinator, the abductor pollicis longus, the extensor pollicis brevis, and the extensor indicis. The dorsal interosseous nerve appears through the substance of the supinator, crosses the surface of the abductor pollicis longus, and dips deep to the extensor pollicis longus. The dorsal interosseous artery appears between the adjacent borders of the supinator and the abductor pollicis longus and descends along the radial border of the extensor carpi ulnaris superficial to the extensor pollicis longus and the extensor indicis. First clean the dorsal interosseous nerve and secure its branches. After it pierces the supinator it gives branches of supply to all the deep muscles except the supinator, and to three of the superficial muscles, viz., the extensor digitorum communis, the extensor digiti quinti, and the extensor carpi ulnaris. The branches to the superficial muscles were found as the extensor digitorum communis and the extensor digiti quinti were reflected. The branch to the extensor indicis is given off before the nerve dips deep to the extensor pollicis longus, and it crosses the superficial surface of the long extensor of the thumb. When it has been found pull the extensor pollicis longus and the extensor indicis towards the medial side, and follow the dorsal interosseous nerve, which passes deep to both of them, to the back of the radius where it enters the osteo-fascial compartment through which the extensor digitorum communis and the extensor indicis pass to the dorsum of the hand. Where it lies under cover of the extensor pollicis longus it is joined by the perforating branch of the volar interosseous artery, which pierces the interosseous membrane about 50 mm. above the wrist, and then accompanies the dorsal interosseous nerve. Pull aside the tendons of the extensor communis and the extensor indicis beyond the dorsal carpal ligament and find the terminal part of the nerve and the continuation of the artery, deep to the tendons on the back of the wrist joint. The nerve ends in a gangliform enlargement from which twigs are distributed to the ligaments of the wrist joint, and the volar interosseous artery terminates by joining the dorsal carpal arterial arch.

Now clean the deep muscles, note the osteo-fascial compartments on the back of the radius through which they pass to the hand, and trace their tendons to their insertions.

Deep Muscles.—These are—(1) the supinator; (2) the abductor pollicis longus; (3) the extensor pollicis brevis; (4) the extensor pollicis longus; and (5) the extensor indicis proprius (Fig. 79).

The supinator will be recognised from the close manner in which it is applied to the proximal part of the body of the radius. The other muscles take origin proximo-distally in the order in which they have been named. The attachments of the supinator cannot be satisfactorily studied at present. They will be described at a later stage of the dissection.

M. Abductor Pollicis Longus (O.T. **Extensor Ossis Metacarpi Pollicis**).—The long abductor of the thumb arises from both bones of the forearm, and from the interosseous membrane, which stretches between them. Its *origin from the radius* corresponds to the middle third of the dorsal surface of that bone; its *origin from the ulna* is more proximal, from the lateral part of the dorsal surface of the body, immediately distal to the oblique line which marks the distal limit of the insertion of the anconæus. The muscle proceeds distally and laterally, and comes to the surface in the interval between the extensor digitorum communis and the extensor carpi radialis brevis. Then it crosses the two radial extensors, closely accompanied by the extensor pollicis brevis. The tendon which issues from it, as it becomes superficial, is continued distally, over the lateral side of the expanded distal end of the radius, and under cover of the dorsal carpal ligament, and is inserted into the lateral side of the base of the metacarpal bone of the thumb. The muscle is supplied by the *dorsal interosseous nerve.* In addition to being an abductor of the thumb it assists in producing supination and abduction of the hand (Figs. 74, 75, 76, 79).

M. Extensor Pollicis Brevis (O.T. **Extensor Primi Internodii Pollicis**).—The short extensor of the thumb is placed along the distal border of the preceding muscle. It arises from a small portion of the dorsal surface of the radius, and also from the interosseous membrane. Its tendon is closely applied to that of the abductor pollicis longus, and accompanies it deep to the dorsal carpal ligament. It must be traced, on the dorsal aspect of the metacarpal bone of the thumb, to the base of the proximal phalanx, into which it is inserted. The muscle is supplied by the *dorsal interosseous nerve.* It is an extensor of the first interphalangeal joint and of the metacarpo-phalangeal joint of the thumb, and it takes a subsidiary part in the production of abduction of the hand.

M. Extensor Pollicis Longus (O.T. **Extensor Secundi Internodii Pollicis**).—The long extensor of the thumb takes origin from the lateral part of the dorsal surface of the body of the ulna, in its middle third, and also from the interosseous membrane. It overlaps, to some extent, the preceding muscle, and it ends in a tendon which passes under cover of the dorsal carpal ligament, where it occupies a deep narrow groove on the dorsum of the distal end of the radius. On the carpus it takes an oblique course, and, after crossing the tendons of the two radial extensors and the radial artery, it reaches the thumb. It is inserted into the base of the distal phalanx of the thumb and is supplied by a branch of the *dorsal interosseous nerve*. It is an extensor of all the joints of the thumb, and it takes part in the initiation of supination of the forearm (Figs. 78, 74, 75, 76, 79).

When the thumb is powerfully extended, in the living person, the tendons of its three last-mentioned muscles become prominent on the lateral aspect of the wrist. The oblique course of the tendon of the extensor pollicis longus is rendered evident, and a distinct depression between it and the other two tendons is seen.

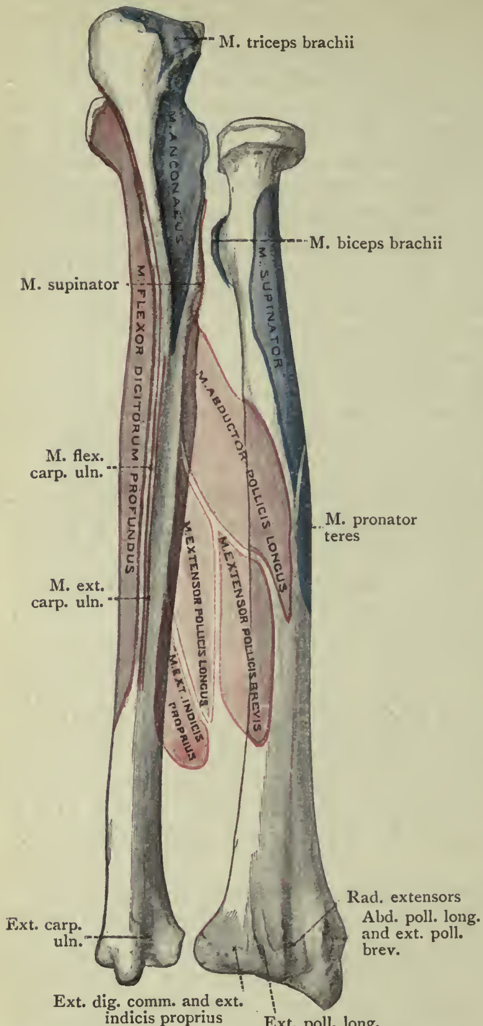


FIG. 78.—Dorsal aspect of the Bones of the Forearm, with Attachments of Muscles mapped out.

M. Extensor Indicis Proprius. — The special extensor of the index finger arises, distal to the preceding muscle, from a limited area on the dorsal surface of the ulna and from the adjacent part of the interosseous membrane. Its tendon accompanies the tendons of the extensor digitorum communis through the most medial groove on the back of the radius, under cover of the dorsal carpal ligament, and is enclosed in the same mucous sheath. On the dorsum of the hand it lies along the medial side of the most lateral tendon of the common extensor, and it terminates in the expansion of that tendon on the dorsum of the first phalanx of the index finger. It is supplied by a branch of the *dorsal interosseous nerve.* It is an extensor of all the joints of the index finger, and it takes part in the production of extension of the wrist joint.

Arteria Interossea Dorsalis. — The dorsal interosseous artery arises, in the front part of the forearm, from the common interosseous branch of the ulnar artery. It at once proceeds dorsally, between the two bones of the forearm, in the interval between the oblique cord and the proximal border of the interosseous membrane. It appears in the back of the forearm between the contiguous borders of the supinator and the abductor pollicis longus, and then it extends distally between the superficial and deep muscles on the dorsum of the forearm. It gives branches to the adjacent muscles, and before it reaches the distal end of the forearm it is greatly reduced in size. In a well-injected limb it will be seen to end on the dorsum of the carpus by anastomosing with the volar interosseous artery and the dorsal carpal arteries. In addition to the branches which it supplies to the muscles, it gives off one large branch called the *interosseous recurrent artery* (Fig. 79).

The *arteria interossea recurrens* takes origin from the parent trunk as it appears between the supinator and the abductor pollicis longus, and turns proximally, under cover of the anconæus muscle, to reach the dorsal aspect of the lateral epicondyle of the humerus.

Nervus Interosseus Dorsalis.—The dorsal interosseous nerve is the continuation of the deep terminal branch of the radial (musculo-spiral) nerve. It reaches the dorsum of the forearm by traversing the substance of the supinator, and at the same time winding round the lateral aspect of the body of the radius. It emerges from the supinator a short distance proximal to the distal border of the muscle, and passes

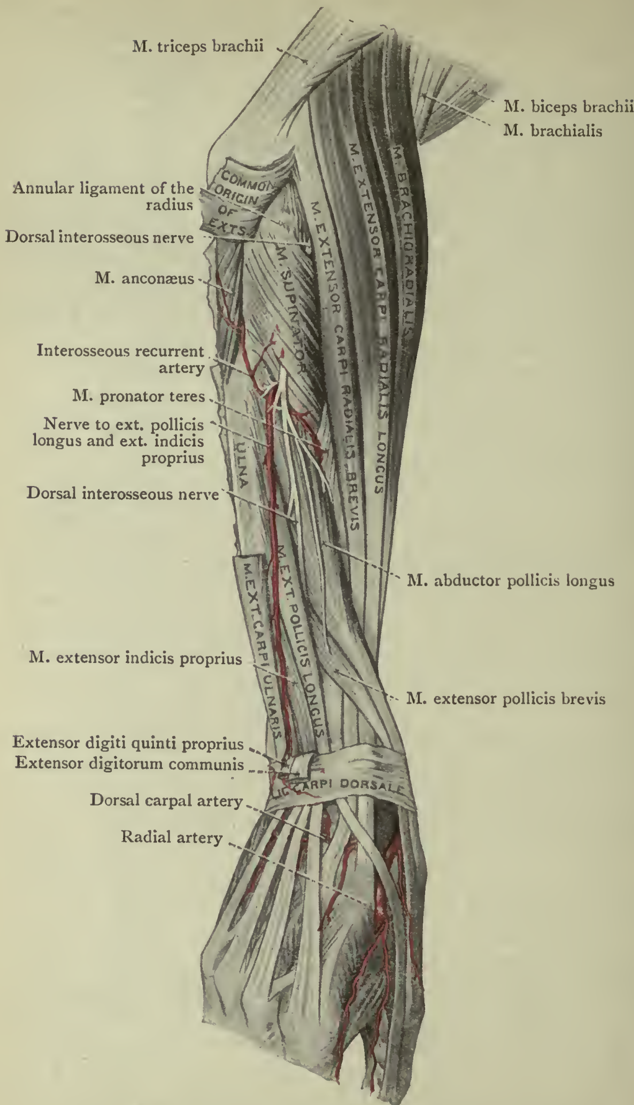


FIG. 79.—Dissection of the Dorsum of the Forearm and Hand.

distally between the superficial and deep muscles on the back of the forearm. At the proximal border of the extensor pollicis longus, it leaves the dorsal interosseous artery, dips anterior to the extensor pollicis longus, and joins the perforating branch of the volar interosseous artery on the dorsal aspect of the interosseous membrane. Accompanied by that artery it descends, through the most medial groove on the back of the radius with the tendons of the extensor digitorum communis and the extensor indicis proprius, to the back of the wrist where it ends in a gangliform enlargement which lies between the extensor tendons and the posterior ligament of the wrist.

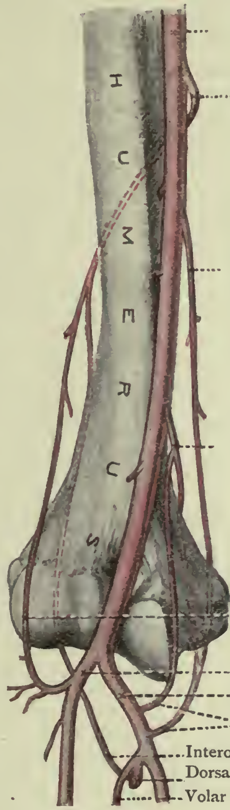


FIG. 80.—Diagram of Anastomosis around the Elbow Joint.

The *branches* which spring from the dorsal interosseous nerve in the forearm are given entirely to muscles. Before the deep branch of the radial nerve pierces the supinator and becomes the dorsal interosseous nerve, it gives branches both to the supinator and to the extensor carpi radialis brevis. After it appears on the dorsum of the forearm, as the dorsal interosseous nerve, it supplies the extensor digitorum communis, the extensor digiti quinti proprius, the extensor carpi ulnaris, the abductor pollicis longus, two extensors of the thumb, and the extensor indicis proprius.

It supplies, therefore, all the muscles on the lateral and dorsal aspects of the forearm, with the exception of the brachio-radialis and the extensor carpi radialis longus, which derive their nerve-supply directly from the *radial nerve* (O.T. *musculo-spiral*). The anconæus derives its main nerve of supply from the radial nerve, but not infrequently it also obtains a second twig from the dorsal interosseous nerve.

Dissection.—Detach the anconæus from its origin and throw it towards its insertion in order to display the course of the dorsal interosseous recurrent artery. Trace that artery to the back of the lateral epicondyle, and then examine the arterial anastomosis around the elbow-joint.

Anastomosis around the Elbow Joint.—The series of inosculations around the elbow should now be reviewed as a whole. A distinct inosculation will be found to take place upon both the anterior and posterior aspect of each epicondyle of the humerus. Behind the lateral epicondyle the *interosseous recurrent artery* joins the *posterior branch* of the *profunda brachii artery:* anterior to the same epicondyle the *anterior branch* of the *profunda brachii artery* communicates with the *radial recurrent.* On the medial side of the joint the *anterior* and *posterior ulnar recurrent arteries* ascend respectively in front of and behind the medial epicondyle; the former anastomoses with the *anterior branch* of the *inferior ulnar collateral artery*, and the latter with the *posterior* branch of the same artery and with the *superior ulnar collateral artery.*

In this account of the anastomosis around the elbow joint only the leading inosculations are mentioned. Rich networks of fine vessels are formed over the olecranon and the two epicondyles of the humerus. One very distinct and fairly constant arch requires special mention. It is formed by a branch which crosses the posterior aspect of the humerus, immediately proximal to the olecranon fossa, and connects the posterior branch of the profunda brachii artery with the posterior branch of the inferior ulnar collateral artery.

Terminal Branch of the Arteria Interossea Volaris.—The so-called perforating branch of the volar interosseous artery is a vessel of some size, and is, really, the main continuation of the artery. It perforates the interosseous membrane about 50 mm. proximal to the distal end of the radius, and is at once joined by the dorsal interosseous nerve. It descends, with the nerve, in the most medial groove on the dorsum of the distal end of the radius, to the dorsum of the carpus, where it anastomoses with the end of the dorsal interosseous artery and terminates in the dorsal carpal arterial arch. As it crosses the back of the distal end of the radius it lies between the bone and the mucous sheath, which encloses the tendons of the extensor digitorum communis and the extensor indicis.

Dorsal Aspect of the Wrist and Hand.

Upon the dorsal aspect of the wrist and hand the following structures have still to be examined :—

1. The dorsal carpal ligament.
2. The radial artery and its branches.
3. The extensor tendons of the fingers.

Ligamentum Carpi Dorsale.—The dorsal carpal ligament is a fascial band which stretches obliquely across the wrist. It is merely a thickened portion of the deep fascia, and its attachments are so arranged that it does not interfere with the free movement of the radius and hand during pronation and supination. On the lateral side it is fixed to the lateral margin of the distal end of the radius, whilst on the medial side it is attached to the os triquetrum and os pisiforme, and also to the palmar aponeurosis. In the case of the transverse carpal ligament one large compartment, or tunnel, is formed for the flexor tendons; not so in the case of the dorsal carpal ligament. Partitions or processes proceed from its deep surface, and are attached to the ridges on the dorsal aspect of the distal end of the radius, so as to form a series of six bridges or compartments for the tendons. Each compartment is lined by a mucous sheath which envelops the tendon or tendons which pass through it, and facilitates their play between the ligament and the bone. The different compartments should now be successively opened up so that the arrangement of the tendons with reference to the dorsal carpal ligament may be studied.

The *first compartment* is placed on the lateral side of the base of the styloid process of the radius, and corresponds with the broad oblique groove which is present in that part of the bone. It contains two tendons, viz., the tendons of the abductor pollicis longus and the extensor pollicis brevis, with their mucous sheaths. The *second compartment* corresponds with the most lateral groove on the dorsal aspect of the radius.

It is broad and shallow, and it holds the tendons of the extensor carpi radialis longus and extensor carpi radialis brevis

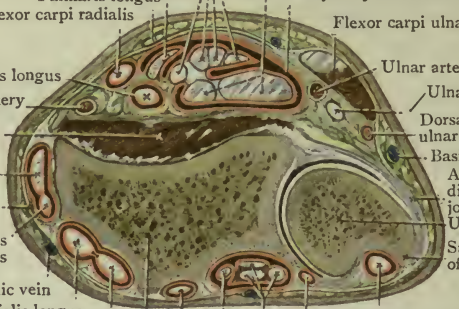


FIG. 81.—Transverse section through Forearm proximal to the Ligamentum Carpi Transversum. Showing the relation of the mucous sheaths to the tendons.

and their mucous sheaths. The *third compartment* is formed over the narrow, deep, oblique intermediate groove on the dorsum of the distal end of the radius. It contains the tendon

FIG. 82.—(From Luschka.)

1. Middle metacarpal bone.
2. Tendon of flexor digitorum sublimis.
3. Tendon of flexor digitorum profundus.
4. Second lumbrical muscle.
5. Second dorsal interosseous muscle.
6. Common extensor tendon.

I., II., and III. The three phalanges.

of the extensor pollicis longus and its mucous sheath. The *fourth compartment* is placed over the wide shallow groove which marks the medial part of the dorsal aspect of the distal end of the radius. It is traversed by tendons of the extensor digitorum communis and the tendon of the extensor indicis proprius and their mucous sheath, and by the terminal parts of the dorsal interosseous nerve and the perforating branch of the volar interosseous artery. The *fifth compartment* is situated over the interval between the distal ends of the radius and ulna. It contains the slender tendon of the extensor digiti quinti proprius and its mucous sheath. The *sixth* and *most medial compartment*, which corresponds with the groove on the dorsum of the distal end of the ulna, encloses the tendon of the extensor carpi ulnaris and its mucous sheath (see Fig. 76).

Dissection. — After the compartments of the dorsal carpal ligament and their contents have been examined displace the various tendons as far as may be necessary, and clean the dorsal part of the radial artery and its branches. The artery enters the dorsal part of the wrist region by curling round the lateral border of the wrist deep to the tendons of the abductor pollicis longus and the short and long extensors of the thumb, and it disappears into the palm, at the proximal end of the first interosseous space, between the two heads of the first dorsal interosseous muscle. As it lies at the side of the wrist two dorsal arteries of the thumb and the dorsal radial carpal branch spring from it, and just before it disappears it gives off the dorsal artery to the index finger, and the first dorsal metacarpal artery, unless that branch rises in common with the dorsal radial carpal artery.

Radial Artery. — Only a small portion of the radial artery is seen in this dissection. At the distal end of the radius the vessel turns dorsally, distal to the styloid process and upon the radial collateral ligament of the radio-carpal joint. Having gained the dorsal aspect of the carpus, it runs distally upon the navicular and os multangulum majus, and finally disappears from view by turning volarwards, through the proximal part of the first interosseous space and between the heads of origin of the first dorsal interosseous muscle (Figs. 75, 76). In the palm it takes the chief share in the formation of the deep volar arch.

While the radial artery rests on the radial collateral carpal ligament, it is deeply placed, and is crossed by the tendons of the abductor pollicis longus and the extensor pollicis brevis. On the carpus it lies nearer the surface, and is crossed obliquely by the extensor pollicis longus. It is accompanied by two *venæ comites* and some fine filaments from the lateral cutaneous nerve of the forearm which twine around it.

The *branches* which spring from the radial artery in this part of its course are of small size. They are:—

1. Ramus carpeus dorsalis.
2. Aa. metacarpeæ dorsales.
3. Aa. digitales dorsales. { Two dorsal arteries of the thumb. One dorsal artery of the index digit.

The *dorsal radial carpal artery* takes origin on the lateral aspect of the wrist, and runs medially, upon the carpus, to join the corresponding carpal branch of the ulnar artery. The arch thus formed is placed under cover of the extensor tendons, and gives off two branches which run distally in the third and fourth inter-metacarpal intervals. They are termed the *second* and *third dorsal metacarpal arteries.*

The *first dorsal metacarpal artery* arises, as a rule, from the radial trunk, although not infrequently it may be seen to spring from the dorsal carpal arch. It extends distally in the second interosseous space.

The three dorsal metacarpal arteries are brought into connection with the arteries in the palm by communicating branches. They are joined by the three perforating twigs of the deep volar arch, which make their appearance on the dorsum of the hand between the heads of the medial three dorsal interosseous muscles. Further, at the distal ends of the interosseous spaces the dorsal metacarpal arteries usually send *distal perforating branches* to join the corresponding common volar digital arteries in the palm.

The *two dorsal arteries of the thumb* run distally one upon each side of that digit.

The *dorsal artery of the index* is distributed on the lateral side of the index finger.

Dissection.—**The limb should now be turned round, so that the transverse metacarpal ligament which stretches across the volar aspects of the heads of the metacarpal bones may be examined previous to the dissection of the interosseous muscles.**

Ligamentum Capitulorum Transversum.—The transverse ligament of the heads of the metacarpal bones is a strong band, composed of transverse fibres, which crosses the volar aspects of the heads of the four metacarpal bones of the fingers. Commencing on the lateral side, upon the distal extremity of the index metacarpal, it ends at the medial margin of the hand, upon the head of the metacarpal bone of the little finger.

It is not directly attached to the bones, but is fixed to the powerful volar accessory ligaments of the medial four metacarpo-phalangeal joints, and it effectually prevents excessive separation of the metacarpal bones from each other.

Dissection.—To obtain a satisfactory view of the interosseous muscles, the transverse part of the adductor pollicis, if not previously reflected, should be detached from its origin, and thrown laterally towards its insertion into the thumb. The transverse metacarpal ligament also must be divided in the intervals between the fingers. Then the palmar and dorsal interossei must be cleaned and their limits must be defined. As the fascia is cleaned from their surfaces the margins of the muscles become evident. There is one dorsal interosseous muscle in each intermetacarpal space, and in the medial three spaces there is also a volar interosseous muscle.

Mm. Interossei.—The interosseous muscles occupy the intervals between the metacarpal bones. They are seven in number, and are arranged in two groups, viz. a dorsal and a volar.

The three *volar interossei* can be seen only on the palmar aspect of the hand. They act as adductors of the index, ring, and little fingers towards the middle digit, and each muscle is placed upon the metacarpal bone of the finger upon which it acts. The *first volar interosseous muscle* therefore arises from the metacarpal bone of the index finger, and its delicate tendon is inserted upon the medial side of that digit, partly into the base of the first phalanx, and partly into the extensor expansion. The *second volar interosseous muscle* springs from the metacarpal bone of the ring finger, and has a similar insertion into the lateral side of that digit. The *third volar interosseous muscle* takes origin from the metacarpal bone of the little finger, and is inserted into the lateral side of the first phalanx and the extensor expansion of that finger.

The *dorsal interossei* are four in number, and are larger than the volar muscles. They are seen best on the dorsal aspect of the hand, but they are visible in the palm also. They act as abductors of the fingers from the central line of the middle digit, and their insertions are arranged in accordance with that action. Each muscle arises by two heads from the contiguous surfaces of the two metacarpal bones between which it lies, and the fibres converge in a pennate manner upon a delicate tendon. In the case of the *first* or *most lateral dorsal interosseous muscle*, the tendon is inserted into the lateral side of the base of the first phalanx, and also into the lateral margin of the dorsal expansion of the extensor tendon of the index. The *second* and *third dorsal interosseous muscles* are inserted in a similar manner, one on each side of the base of the first phalanx of the middle finger; whilst the *fourth* has a corresponding insertion upon the medial aspect of the base of the first phalanx of the ring finger.

The first dorsal interosseous muscle is frequently termed the *abductor indicis*; and between its two heads of origin the radial artery enters the palm. Between the heads of the other three muscles the small perforating arteries pass.

In addition to acting as adductors or abductors of the fingers the interossei flex the metacarpo-phalangeal joints and help to extend the interphalangeal joints (see p. 178). The interosseous muscles are supplied by the *deep branch* of the *ulnar nerve*.

Tendon of the Flexor Carpi Radialis.—The tendon of the radial flexor of the carpus should now be traced through the groove on the volar aspect of the os multangulum majus to its insertion into the base of the metacarpal bone of the index finger. It presents also a minor attachment to the base of the middle metacarpal bone. On its way to its insertion it passes behind the tendon of the flexor pollicis longus.

Dissection.—**All the muscles around the elbow joint should be removed. As the brachialis and the triceps are raised from the anterior and posterior aspects of the articulation, some care is required to avoid injury to the anterior and posterior parts of the capsule. It is advisable to remove the supinator last, because it is only when that muscle is completely isolated that a proper idea of its attachments and mode of action can be obtained. Before it is removed its attachments and actions must be studied.**

M. Supinator (O.T. **Supinator Brevis**).—The supinator muscle envelops the proximal part of the body and the neck of the radius, covering it completely, except on its medial side (Figs. 64, 78). It arises from the deep depression distal to the radial notch of the ulna, and also from the radial collateral ligament of the elbow and the annular ligament of the radius. From their origin the fibres sweep round the dorsal, lateral, and volar surfaces of the radius, and clothe its body as far distally as the insertion of the pronator teres. The dorsal interosseous nerve supplies the muscle, traverses its substance, and separates it into two layers.

ARTICULATIONS.

ARTICULATIO CUBITI (ELBOW JOINT).

This joint includes (1) the articulatio humero-ulnaris, (2) the articulatio humero-radialis, and (3) the articulatio radio-ulnaris proximalis. In the humero-ulnar articulation the trochlea of the humerus is grasped by the *semilunar notch* of the ulna. In the radio-humeral articulation the *capitulum of the humerus* rests in the shallow *fovea capituli* of the radius, and in the proximal radio-ulnar articulation the *articular circumference* of the head of the radius is held in apposition with the *radial notch* of the ulna by the *annular ligament* (Figs. 85, 96).

The joint is surrounded by a capsule which is reinforced at the sides by collateral ligaments; in addition, the interosseous membrane, which passes between the interosseous crests of the radius and ulna, and the oblique cord, which connects the tuberosity of the ulna with the proximal part of the interosseous crest of the radius, help to keep the radius and ulna in apposition, and are therefore included in the ligaments of the elbow joint. The ligaments of the elbow joint are therefore—

1. Capsula articularis.
2. Lig. collaterale ulnare.
3. Lig. collaterale radiale.
4. Lig. annulare radii.
5. Membrana interossea antibrachii.
6. Chorda obliqua.

The *articular capsule* is attached proximally to the antero-medial and antero-lateral surfaces of the humerus, proximal to the coronoid and radial fossæ, respectively. At the sides, it is attached to the epicondyles; and, posteriorly, to the posterior surface, on which the line of attachment passes through the proximal part of the olecranon fossa. Distally, the capsule is attached to the anterior margin of the proximal, medial, and lateral surfaces of the olecranon; to the medial and volar margins of the coronoid process of the ulna, and to the annular ligament of the radius. The anterior part of the capsule consists of fibres which take an irregular course over the anterior aspect of the joint. The posterior part of the capsule is weaker than the anterior and its attachment to the posterior surface of the humerus is comparatively loose.

The cavity of the joint is closed distally on the radial side by lax fibres which pass from the distal border of the annular ligament to the neck of the radius, and by a thin sheet of fibres, called the *ligamentum quadratum*, which extends from the medial side of the neck of the radius to the distal border of the radial notch of the ulna.

Ligamentum Collaterale Radiale (O.T. **External Lateral Ligament**).—The radial collateral ligament is a strong but short band which is attached proximally to the distal aspect of the lateral epicondyle of the humerus. Distally, it is fixed to the annular ligament of the radius, and also, more posteriorly, to the lateral side of the olecranon of the ulna. The annular ligament is a strong ligamentous collar which surrounds the head of the radius, and retains it in the radial notch of the ulna.

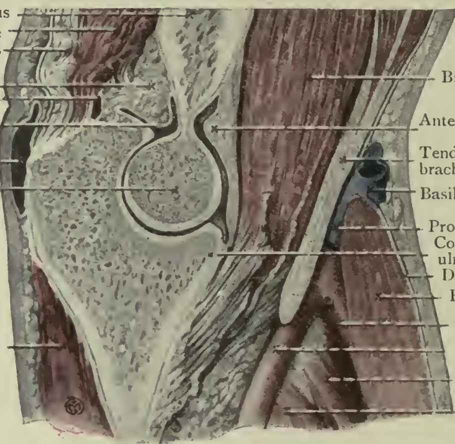


FIG. 83.—Sagittal section of the Right Elbow Region.

Ligamentum Collaterale Ulnare (O.T. **Internal Lateral Ligament**).—The ulnar collateral ligament, taken as a whole, is fan-shaped. By its proximal pointed part it is attached to the medial epicondyle of the humerus. Distally it spreads out and is inserted into the coronoid process and the olecranon. It consists of three very distinct portions, viz., an anterior, a posterior, and a transverse (Fig. 84).

The *anterior part* springs from the distal and anterior part of the medial epicondyle, and is attached to the medial margin of the coronoid process of the ulna. The *posterior part* is attached, proximally, to the distal and dorsal part of the medial epicondyle, whilst distally, it is fixed to the medial border of the olecranon. The *transverse part* consists of a band of fibres which bridges across the notch between the olecranon and the coronoid process, to both of which it is attached.

The annular ligament and the oblique cord will be described later (see pp. 202-204).

Stratum Synoviale (Synovial Membrane).—The joint should be opened by making a transverse incision through the anterior part of the capsule. The synovial stratum will be seen lining the deep surface of the capsule, from which it is

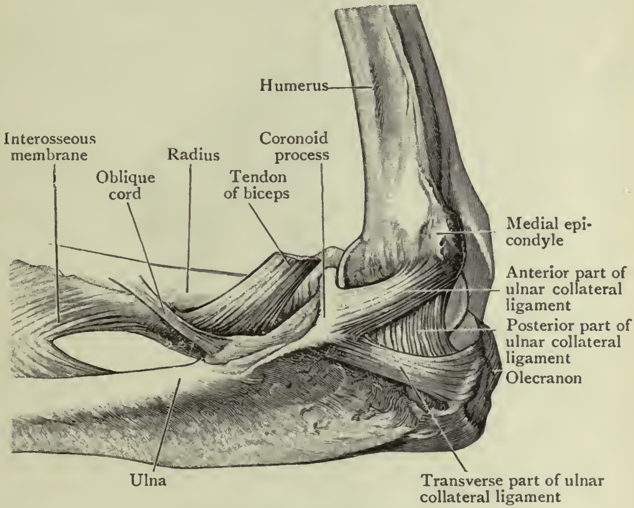


FIG. 84.—Medial aspect of Elbow Joint.

reflected upon the non-articular parts of the bones which are enclosed within the capsule. Anterior to the humerus it lines the radial and coronoid fossæ, and posteriorly it is prolonged proximally, in the form of a loose diverticulum, into the olecranon fossa. In the fossæ a quantity of soft oily fat is developed between the bone and the synovial stratum. In that way pliable pads are formed which occupy the recesses when the bony processes are withdrawn from them.

Distally, the synovial stratum of the elbow joint is prolonged into the proximal radio-ulnar joint, so that both articulations possess a single, continuous synovial cavity.

The nerve supply of the joint is derived from the median, ulnar, and radial nerves.

Movements at the Elbow Joint.—The movements at the elbow joint must not be confounded with those that take place at the proximal radio-ulnar joint. At the elbow joint two movements, viz., *flexion*, or forward movement of the forearm, and *extension*, or backward movement of the forearm, are permitted.

The *muscles* which are chiefly concerned in flexing the forearm upon the

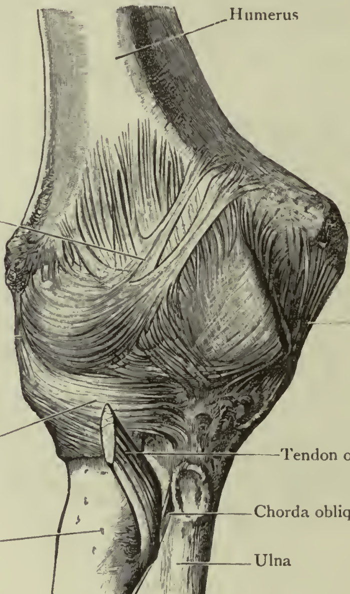


FIG. 85.—Anterior aspect of the Elbow Joint.

arm at the elbow joint are the biceps, the brachialis, the muscles attached to the medial epicondyle, and the brachio-radialis. The muscles which extend the forearm are the triceps and anconæus and the muscles which spring from the lateral epicondyle.

Dissection.—It is advisable to study the radio-carpal or wrist joint, before the articulations between the two bones of the forearm are examined. The transverse, volar, and dorsal carpal ligaments, together with the extensor and flexor tendons, should be completely removed from the wrist. No attempt, however, should be made to detach the extensor tendons from the dorsal aspects of the fingers and thumb. The short muscles of the thenar and hypothenar eminences must also be taken away.

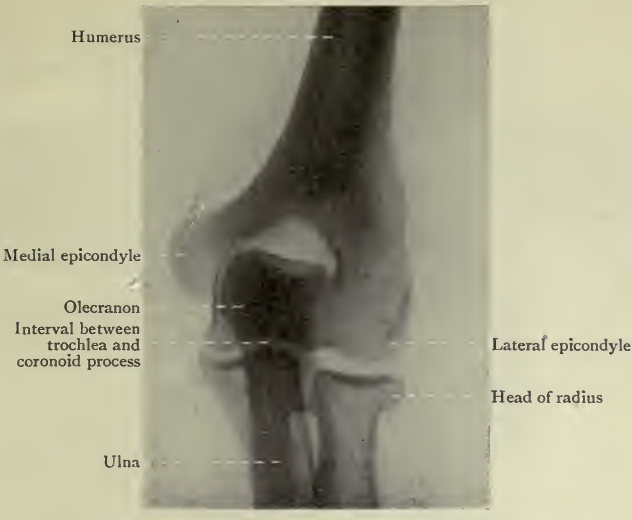


FIG. 86.—Antero-posterior Radiograph of extended Elbow Joint. (Mr. A. D. Reid.)

FIG. 87.—Lateral Radiograph of extended Elbow Joint. (Dr. R. Knox.)

PLATE XII

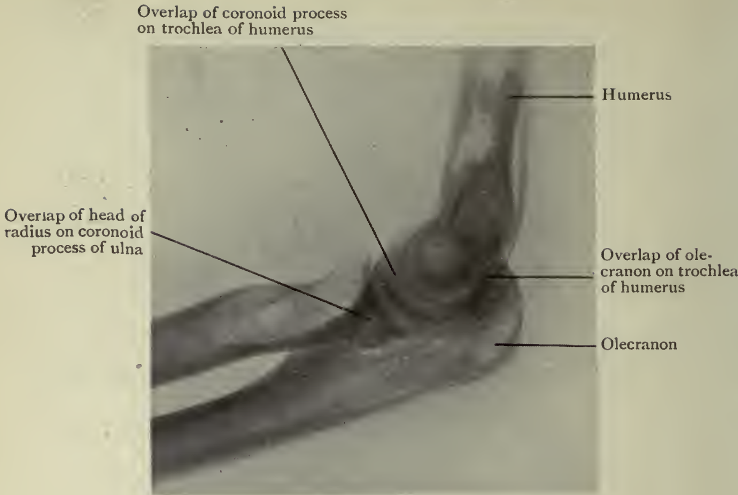


FIG. 88.—Lateral Radiograph of partly bent Elbow.

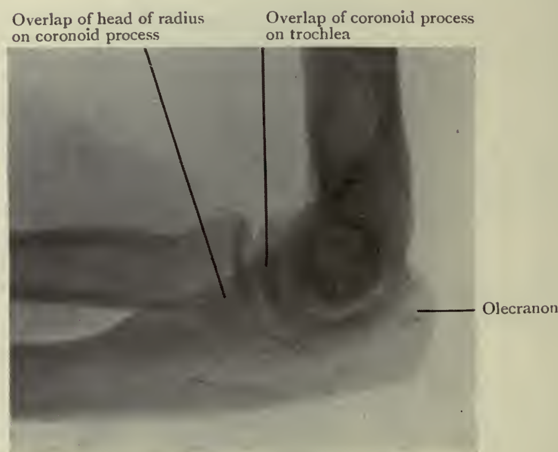


FIG. 89.—Lateral Radiograph of half-bent Elbow.
(Mr. Martin.)

PLATE XIII

FIG. 90.—Radiograph of the Elbow Joint.

Note (1) The medial epicondyle has not yet united with the shaft.
(2) The proximal epiphysis of the radius.
(3) That the nodular epiphysis of the olecranon is not distinctly visible.
(4) That all the distal epiphyses of the humerus have fused with the shaft except the epiphysis of the medial epicondyle.

(Mr. A. D. Reid.)

PLATE XIV

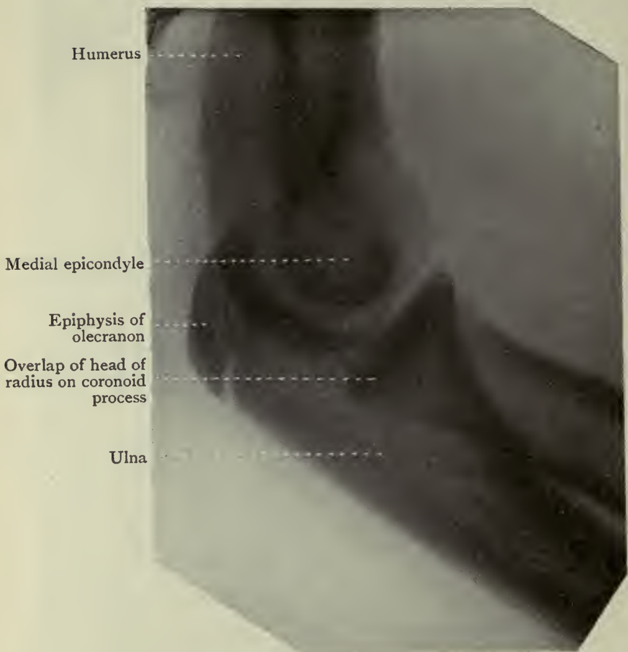


FIG. 91.—Lateral Radiograph of a partly bent Elbow Joint, showing Epiphysis of Olecranon.

(Mr. A. D. Reid.)

PLATE XV

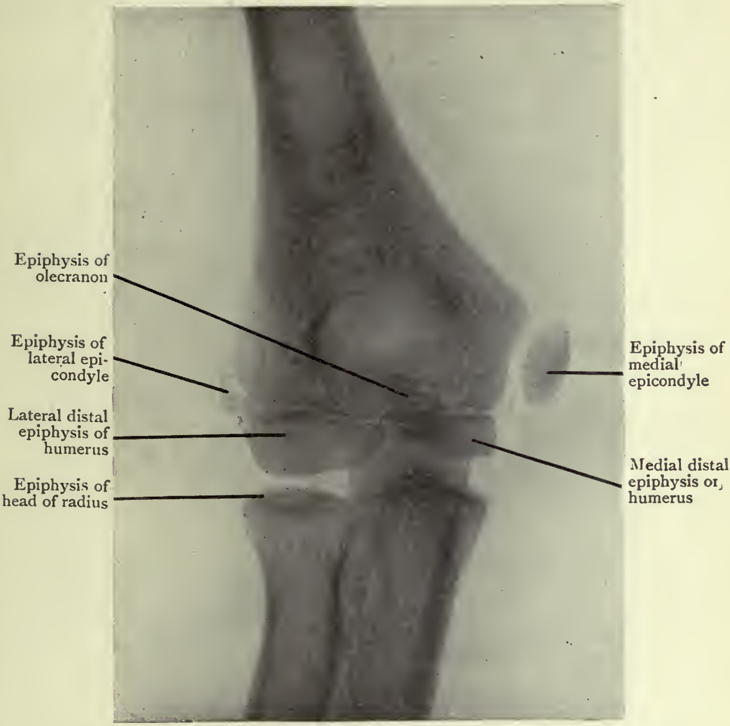


FIG. 92.—Antero-posterior Radiograph of young Elbow Joint, showing all Epiphyses.

PLATE XVI

FIG. 93.—Antero-posterior Radiograph of young Elbow Joint. The epiphysis of the lateral epicondyle of the humerus has not yet appeared.

Note that the lateral distal epiphysis forms not only the capitulum of the humerus but also a part of the trochlea.

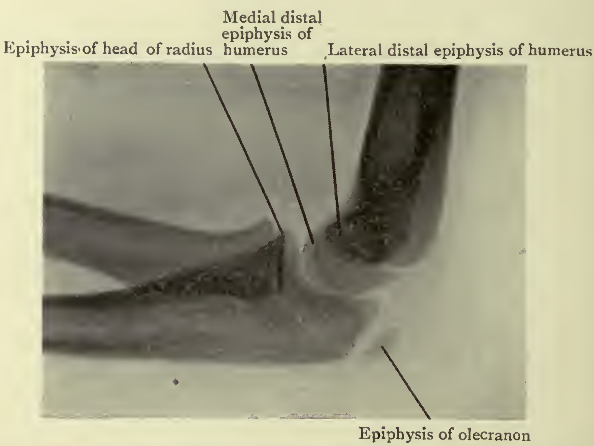


FIG. 94.—Lateral Radiograph oi a half-bent young Elbow Joint.

Articulatio Radio-carpea (Wrist Joint).

The radio-carpal or wrist joint is the joint between the forearm and the hand. The proximal face of the joint is formed by the distal articular surface of the radius and the discus articularis; and the distal surface consists of the navicular, lunate, and triquetral bones, and the two interosseous ligaments which connect them together. The opposed surfaces are retained in apposition by an *articular capsule* in which at least four thickened bands can be recognised, they are:—

1. Lig. radiocarpeum volare.
2. Lig. radiocarpeum dorsale.
3. Lig. collaterale radiale.
4. Lig. collaterale ulnare.

The *capsule* is attached proximally to the borders of the distal ends of the radius and the ulna, and to the borders of the articular disc. Distally it is connected with the bones of the proximal row of the carpus, with the exception of the pisiform, and some of its fibres can be traced to the capitate bone.

The *volar radio-carpal ligament* springs from the anterior border of the styloid process of the radius and the adjacent part of the anterior border of the distal end of the radius. Distally it breaks up into flat bands which are attached to the navicular, lunate, and capitate bones. In many cases a volar *ulnar-carpal* ligament also is found. When present, it extends from the anterior aspect of the base of the styloid process and the adjacent anterior part of the head of the ulna to the triquetral, pisiform, and capitate bones.

The *dorsal radio-carpal band* springs from the posterior border of the distal end of the radius, and is attached distally to all the bones of the proximal row of the carpus, except the pisiform. Its fibres are often separable into a number of distinct bands.

The *radial collateral carpal ligament* passes from the tip of the styloid process of the radius to the lateral part of the navicular; and the *ulnar collateral carpal ligament* connects the styloid process of the ulna with the triquetral bone.

Articular Surfaces.—Divide the anterior and collateral parts of the capsule by a transverse incision carried across the front of the articulation. The hand can now be bent backwards, so as to expose fully the articular surfaces opposed to each other in this joint.

The *carpal surface* is composed of the proximal articular facets of the navicular and lunate bones, and a very small articular facet on the extreme lateral part of the proximal surface of the triquetral bone. Two interosseous ligaments stretch across the narrow intervals between the three bones —one on each side of the lunate bone—and complete the carpal surface. The carpal surface thus formed is convex in all directions. Further, it should be observed that the articular surface extends distally to a greater extent on the dorsal than on the volar aspect.

The *proximal surface* or *socket* (Fig. 97) is elongated from side to side, and concave in all directions. The greater part of it is formed by the distal end of the radius, but, on the medial side, the articular disc of the distal radio-

FIG. 95.—Carpal Articular Surfaces of the Radius and of the Articular Disc of the Wrist.

ulnar joint also enters into its construction. The distal articular surface of the radius extends further distally on its dorsal and lateral sides than on its volar and medial sides, and it is divided by a low ridge into a lateral triangular and a medial quadrilateral facet. The lateral facet, in the ordinary position of the hand, is in contact with the greater extent of the proximal articular surface of the navicular bone. The medial facet of the radius, together with the articular disc, forms a much larger surface, triangular in outline, which is opposed to the proximal articular surface of the lunate bone. When the hand is placed in line with the forearm no part of the proximal articular surface is allotted to the triquetral bone: its small articular facet rests against the medial part of the capsule of the joint. When the hand is moved medially (*i.e.* adducted), however, the triquetral bone travels laterally, and its articular surface comes into contact with the distal surface of the articular disc. The lunate bone at the same time crosses the bounding ridge on the distal surface of the radius, and encroaches on the territory of the navicular bone, whilst a considerable part of the surface of the navicular bone leaves the radius and comes into contact with the lateral part of the capsule.

Stratum Synoviale.—The synovial stratum of the radio-carpal joint lines the fibrous capsule and it covers the proximal surfaces of the two interosseous ligaments which complete the carpal surface. Sometimes the articular disc is imperfect, and in those cases the synovial stratum of the radio-carpal joint becomes continuous with the synovial stratum of the distal radio-ulnar joint.

The nerve supply is derived from the volar and dorsal interosseous nerves.

Movements at the Radio-carpal Joint.—The hand can be moved in four directions at the radio-carpal joint. Thus we have—(*a*) volar movement, or *flexion*; (*b*) dorsal movement, or *extension*; (*c*) ulnar movement, or *adduction*; (*d*) radial movement, or *abduction.* In estimating the extent of these movements in the living person the student is apt to be misled by the increase of range which is contributed by the carpal joints. Thus, flexion is in reality more limited than extension, although by the combined action of both carpal and radio-carpal joints the hand can be carried much more freely volarwards than dorsalwards. Adduction, or ulnar flexion, can be produced to a greater extent than abduction, or radial flexion. In both cases the extent of movement at the radio-carpal joint proper is very slight, but the range is extended by movements of the carpal bones. The styloid process of the radius interferes with abduction.

The *muscles* which are chiefly concerned in producing the different movements of the hand at this joint are the following:—(*a*) *flexors*—the flexor carpi radialis, the palmaris longus, and the flexor carpi ulnaris; (*b*) *extensors*—extensor carpi radialis longus, the extensor carpi radialis brevis, and the extensor carpi ulnaris; (*c*) *abductors*, or *radial flexors*—flexor carpi radialis, extensor carpi radialis longus, abductor pollicis longus, and the extensor pollicis brevis; (*d*) *adductors*, or *ulnar flexors*—extensor carpi ulnaris and flexor carpi ulnaris.

In addition, all the muscles whose tendons cross the volar aspect of the joint can, under certain conditions, assist in the production of flexion, and the muscles whose tendons cross the dorsal surface can assist in the production of extension.

Articulationes Radio-ulnares (Radio-ulnar Joints).

At the two radio-ulnar joints, proximal and distal, the movements of pronation and supination take place. At the *proximal joint* the medial part of the head of the radius fits into the radial notch of the ulna; at the *distal joint* the small capitulum of the ulna is received into the ulnar notch on the medial side of the distal end of the radius. In connection with these joints there are special ligaments which retain the bones in apposition. They are—(1) for the proximal radio-ulnar joint, *the annular ligament*; and (2) for the distal radio-ulnar joint, (*a*) a *capsule*, and (*b*) the *discus articularis*.

In addition there are other ligaments which pass between the bodies of the two bones of the forearm, and are, therefore, common to the two articulations, viz., the *oblique cord* and the *interosseous membrane*.

> ***Dissection.***—To expose the oblique cord and the interosseous membrane, remove, completely, the volar and dorsal muscles of the forearm.

Ligamentum Annulare Radii (O.T. **Orbicular Ligament**).—The annular ligament is a strong fibrous collar which

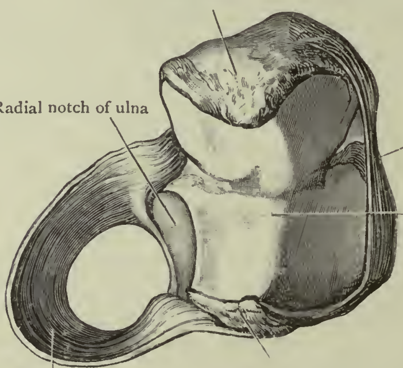


FIG. 96.—Annular Ligament of the Radius.

encircles the head of the radius and retains it in the radial notch of the ulna. It forms four-fifths of a circle, and is attached by its extremities to the volar and dorsal margins of the radial notch of the ulna. It is somewhat narrower distally than proximally, so that, under ordinary circumstances, the head of the radius cannot be withdrawn from it in a distal direction, and it is braced tightly towards the elbow, and greatly strengthened by the anterior and posterior portions of the capsule of the elbow joint and by the radial collateral ligament, which are attached to its proximal border. Its distal border is attached, loosely, to the neck of the radius by a prolongation of the synovial stratum, which is covered externally by a thin layer of fibrous tissue.

The Capsule of the Distal Radio-ulnar Joint.—This capsule consists of lax fibres which can have little influence in retaining the distal extremities of the bones in apposition. It is attached to the volar and dorsal surfaces of both bones of the forearm, to the most distal parts of the interosseous crests and to the volar and dorsal borders of the articular disc. A diverticulum of the capsule, which is prolonged from the joint area for some distance proximally, between the bones of the forearm, is called the *recessus sacciformis.*

Discus Articularis (O.T. **Triangular Fibro-Cartilage**).—The articular disc is the true bond of union at the distal radio-ulnar joint. It has already been noticed in connection with the radio-carpal joint, where it extends the radial articular surface in a medial direction, and is interposed between the distal end of the ulna and the lunate and triquetral bones. It is a thick, firm plate, attached by its base to the distal margin of the ulnar notch of the radius. The apex of the disc is placed medially, and is fixed to the depression on the distal end of the ulna at the root of the styloid process. It intervenes between the distal radio-ulnar joint and the radio-carpal joint (Fig. 97).

Stratum Synoviale (Synovial Membrane).—The synovial stratum of the proximal radio-ulnar joint is continuous with that of the elbow joint. It is prolonged distally to line the annular ligament, and it protrudes beyond that ligament for a short distance upon the neck of the radius.

The cavity of the distal radio-ulnar joint and the synovial stratum are prolonged between the head of the ulna and the articular disc.

Sometimes the articular disc is perforated ; when that is the case, the distal radio-ulnar joint-cavity communicates with the cavity of the radio-carpal joint.

Membrana Interossea Antibrachii.—The interosseous membrane is a fibrous membrane which stretches across the interval between the two bones of the forearm, and is attached to the crista interossea of each. Its proximal border is situated about 25 mm. (one inch) distal to the tuberosity of the radius. Distally, it blends with the capsule of the distal radio-ulnar joint. The fibres which compose it run for the most part obliquely distally and medially from the radius to the ulna, although several strands may be noticed taking an opposite direction. The dorsal interosseous vessels pass backwards, above its proximal margin, between the two bones of the forearm; whilst the terminal branch of the volar interosseous artery pierces it about two inches from its distal end. The membrane braces the two bones together in such a manner that forces, passing proximally through the radius, are transmitted from the radius to the ulna; and it extends the surface of origin for the muscles of the forearm. By its volar surface it gives origin to the flexor digitorum profundus and the flexor pollicis longus muscles, whilst from its dorsal surface spring fibres of the two extensor muscles of the thumb, the abductor pollicis longus, and the extensor indicis proprius.

Chorda Obliqua (O.T. **Oblique Ligament**).—The oblique cord is a weak band of fibres which springs from the tuberosity of the ulna. It extends obliquely, distally and laterally, to find its attachment to the radius, immediately distal to the tuberosity of that bone. It crosses the open space between the bones of the forearm proximal to the proximal border of the interosseous membrane. The oblique cord is often absent; and unless the utmost care is taken in removing the adjacent muscles it is apt to be injured.

Movements at the Radio-ulnar Joints.—The movements of pronation and supination take place at the radio-ulnar joints. When the limb is in a condition of complete supination the thumb is directed laterally, the two bones of the forearm are parallel, the radius lying along the lateral side of the ulna. In the movement of pronation the radius is thrown across the ulna, so that its distal end comes to lie across the volar surface and on the medial side of the ulna. Further, the hand moves with the radius, and when the movement is completed the dorsal aspects of the hand and the forearm are directed forwards, and the thumb is turned medially.

The dissector should analyse, as far as possible in the part upon which he is engaged, the movements at the two radio-ulnar joints which produce these effects. At the same time it is to be remembered that results obtained from a limb in which the dissection has proceeded so far are apt to be deceptive. Therefore the dissector should use himself and his friends as subjects on which to study the movements.

In the case of the *proximal radio-ulnar joint* the movement is simple enough. The head of the radius merely rotates within the annular ligament, and accuracy of motion is obtained by the fovea capituli radii resting and moving upon the distal end of the humerus. It should be noticed that the head of the radius does not fit accurately upon the capitulum in all positions of the elbow joint. In extreme extension and extreme flexion of the elbow it is only partially in contact with it. Therefore the semi-flexed condition of the elbow joint places the radius in the most favourable position for free and precise movement at the proximal radio-ulnar joint (Figs. 86, 87, 88, 91, 92, 93).

At the *distal radio-ulnar joint* the distal end of the radius revolves around the distal end of the ulna. It carries the hand with it, and describes the arc of a circle, the centre of which corresponds to the attachment of the articular disc to the distal end of the ulna. As the movement occurs the articular disc moves with the radius, and travels dorsally on the distal end of the ulna in supination, and towards the volar surface in pronation.

But the question may be asked, Does the ulna move during pronation and supination? When the elbow joint is extended to its fullest extent the ulna remains almost immovable. When, however, pronation and supination are conducted in the semi-flexed limb, the ulna does move. A small degree of lateral movement at the elbow joint is allowed, and the distal end of the ulna during pronation is carried slightly dorsally and laterally, and in the reverse direction during supination.

The *muscles* which are chiefly concerned in producing *supination* of the forearm are — the biceps brachii, the brachio-radialis and the supinator. They are aided by the long abductor and the long extensor of the thumb. The biceps brachii, from its insertion into the dorsal part of the tuberosity of the radius, is placed in a very favourable position, in so far as its supinating action is concerned. The muscles which act as *pronators* of the limb are —the pronator teres, the pronator quadratus, and, to a certain extent, the flexor carpi radialis. The pronator teres, from its insertion into the point of maximum lateral curvature of radius, can exercise its pronating action to great advantage. The balance of power is in favour of the supinators, on account of the preponderating influence of the biceps.

Dissection.—**The annular ligament should be cut through, and the oblique cord and the interosseous membrane should be divided proximo-distally. By drawing the radius laterally and opening the capsule of the distal radio-ulnar joint, the proximal surface of the discus articularis of the wrist will be displayed and its attachments more fully appreciated.**

Articulationes Carpeæ (Carpal Joints).

In the carpus two joints are recognised—

1. Articulatio ossis pisiformis.
2. Articulatio intercarpea.

Pisiform Joint.—The pisiform bone articulates with the volar surface of the triquetral bone, to which it is attached by an articular capsule. The cavity of the pisiform joint is quite distinct from those of the adjacent joints.

The dissector has previously noted that the tendon of the flexor carpi ulnaris is inserted into the pisiform bone, and as the capsule would be quite incapable by itself of with-standing the strain to which this muscle subjects the articulation, certain accessory bands are provided which anchor the pisiform firmly in place—they are the piso-hamate and the piso-metacarpal bands. The former passes from the distal end of the pisiform to the hook of the hamate bone; and the latter attaches the pisiform to the proximal ends of the fourth and fifth metacarpal bones.

Articulatio Intercarpea (Intercarpal Joint).

The intercarpal joint has one joint cavity, but it includes not only the articulations between the proximal and distal

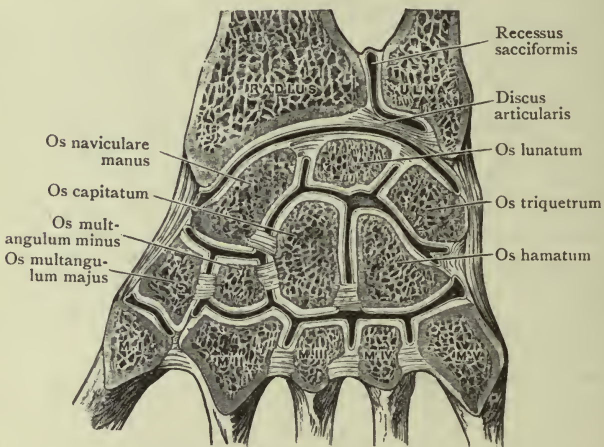


Fig. 97.—Frontal section through Radio-carpal, Carpal, and Carpo-metacarpal and Inter-metacarpal Joints to show Joint Cavities and Interosseous Ligaments (diagrammatic).

rows of carpal bones, which form the *transverse part* of the joint, but also the articulations between the bones of the proximal row and those between the bones of the distal row. The main part of the cavity of the joint lies between the proximal and distal rows; but two prolongations pass proximally, one between the lunate and navicular bones, and the other between the lunate and triquetral bones, and three diverticula are prolonged between the bones of the distal row, beyond which they become continuous with the cavity of the carpo-metacarpal joint (Fig. 97).

The bones of the proximal row are connected together by two dorsal, two volar, and two interosseous ligaments, which pass from the lunate bone to the navicular and triquetral bones, which lie to either side of it. The two interosseous ligaments are composed of short, stout fibres which pass between the non-articular portions of the opposed surfaces of the bones. They are readily seen from the proximal aspect, where they complete the distal surface of the radio-carpal joint.

The members of the distal row of carpal bones are bound together by three dorsal, three volar, and three interosseous ligaments which pass transversely between the adjacent bones. The interosseous ligament between the capitate and the hamate bones is very strong; that between the capitate bone and the lesser multangular bone is weak and not uncommonly absent.

At present the interosseous ligaments between the bones of the distal row are hidden from view, but they can be studied when the transverse part of the intercarpal joint is opened.

The transverse part of the intercarpal joint lies between the proximal and distal rows of carpal bones. The two rows of bones are bound together by an articular capsule which is attached to the volar and dorsal surfaces and the medial and lateral borders of each row. The lateral and medial parts of the capsule are sometimes spoken of as the radial and ulnar ligaments of the transverse carpal joint. The volar and dorsal parts of the capsule are strengthened by numerous bands of fibres. The bands on the dorsal surface are irregular in number and strength, but those on the volar surface are better marked and, for the most part, they radiate from the capitate to the surrounding bones, forming the *ligamentum carpi radiatum*. One of the bands of this ligament passes from the capitate bone to the styloid process of the radius and blends with the radial collateral ligament of the radio-carpal joint.

Articular Surfaces.—The individual bones of the proximal row and the individual bones of the distal row articulate with one another by flat surfaces. In the transverse part of the intercarpal articulation the proximal parts of the capitate bone and the hamate bone form a high convexity which fits into a concavity formed by the distal surfaces of the triquetral and lunate bones and the distal part of the medial surface of the navicular bone; and the convex distal surface of the navicular bone is received into a concavity formed by the proximal surfaces of the greater and lesser multangular bones. The two opposed surfaces of the transverse part of the joint are, therefore, concavo-convex from side to side, and adapted one to the other (Figs. 97, 98).

Movements at the Carpal Joints.—The movements at the carpal joints supplement those at the radio-carpal joint, and tend greatly to increase the range of movement at the wrist. Between the individual bones of each row the movement is of a gliding character, and very limited. At the transverse intercarpal joint volar and dorsal movements (flexion and extension) alone are allowed.

By the multiplicity of joints in this part of the limb, strength and elasticity are contributed to the wrist.

The nerve supply of the radio-carpal and intercarpal joints is derived from the median, ulnar, radial and musculo-cutaneous nerves.

> ***Dissection.***—**The interosseous muscles should now be removed from the metacarpal bones. At the same time the flexor tendons and lumbrical muscles may be detached from the fingers. The extensor tendons, however, should be left in position on the dorsal surfaces of the metacarpo-phalangeal and interphalangeal joints. The ligaments which connect the carpus and metacarpus, and those which pass between the bases of the medial four metacarpal bones, should be cleaned and defined.**

Articulationes Intermetacarpeæ (Intermetacarpal Joints).

The four metacarpal bones of the fingers articulate with one another by their basal or proximal extremities, and are united together by strong ligaments. The metacarpal bone of the thumb stands aloof from its neighbours, and enjoys a much greater freedom of movement.

The ligaments which bind the medial four metacarpal bones to each other are—

1. A series of *volar* and *dorsal* bands, which pass transversely and connect their basal extremities.

2. *Three* stout *interosseous ligaments*, which occupy the intervals between the basal ends of the bones.

3. The *transverse ligaments of the heads*, which connect the heads or distal extremities of the bones (p. 192). This ligament has been removed in the dissection of the interosseous muscles.

PLATE XVII

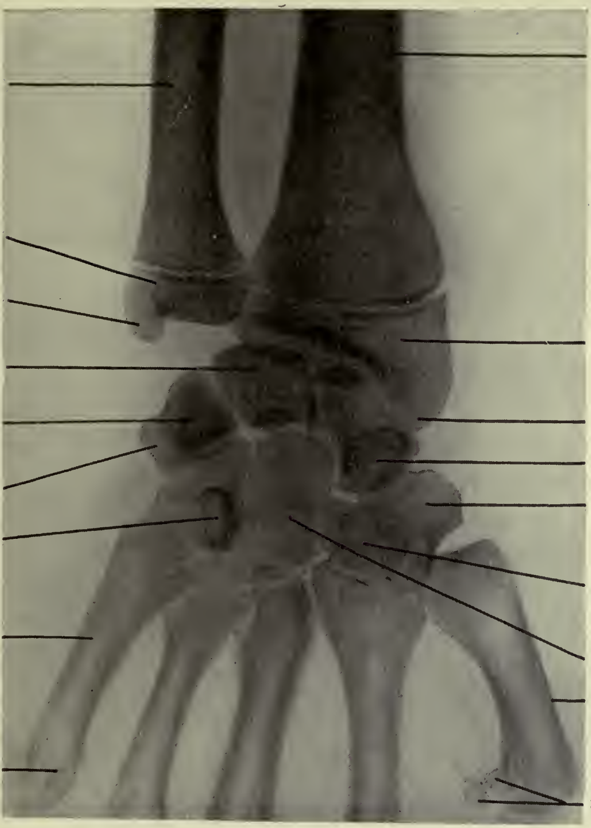


FIG. 98.—Antero-posterior Radiograph of the Wrist of a Person of 19 years.

Note (1) The epiphyseal lines of the radius and ulna.
(2) The difference in level of the styloid process of the ulna as contrasted with the styloid process of the radius.
(3) The overlap of the shadows of adjacent bones.

PLATE XVIII

FIG. 99.—Radiograph of the Bones of the Adult Wrist and Hand. (Dr. C. Gouldesbrough).

FIG. 100.—Radiograph of the Wrist and Hand of a Child 5 years old. Note the epiphyses of the various bones and the absence of any trace of the multangulum majus.

The *interosseous ligaments* cannot be seen at present, but can be studied later when the bases of the metacarpal bones are separated from each other.

Articulationes Carpometacarpeæ (Carpo-metacarpal Joints).

The *metacarpal bone* of the *thumb* articulates with the greater multangular bone by a joint which is quite distinct from the other carpo-metacarpal articulations. An articular capsule surrounds the joint, and is sufficiently lax to allow a very considerable range of movement. On the dorsal and lateral aspects of the articulation it is specially thickened. Its cavity is distinct from that of the adjacent articulations.

The *medial four metacarpal bones* are connected to the carpus by *volar* and *dorsal ligaments*, and by *one interosseous ligament.*

Each of these metacarpal bones, with the exception of the fifth, possesses, as a rule, two dorsal ligaments and one volar ligament. The articulation of the fifth metacarpal bone is also closed on the medial side by ligamentous fibres.

The *interosseous ligament* springs from the contiguous distal margins of the capitate and hamate bones, and passes to the medial side of the base of the third metacarpal bone.

Dissection.—To display the interosseous ligament, divide the bands which connect the bases of the third and fourth metacarpal bones, and sever the dorsal ligaments which bind the medial two metacarpal bones to the carpus. The metacarpal bones thus set free can then be forcibly bent volarwards, when the ligament in question will come into view.

Synovial Membranes of the Carpal, Carpo-metacarpal, and Intermetacarpal Joints.—The articulation between the pisiform and the triquetral bones and the carpo-metacarpal joint of the thumb both possess separate capsules; but the various ligaments of the intercarpal, carpo-metacarpal, and proximal intermetacarpal joints, though they are spoken of individually as separate ligaments, constitute collectively a single capsule, which surrounds a continuous joint cavity. The synovial stratum of the capsule is prolonged over all parts of the bones, enclosed within the capsule, which are not covered by articular cartilage, and it is continued proximally between the three bones of the proximal row of the carpus as far as the interosseous ligaments which connect the bones together. It covers the distal surfaces of those ligaments and is excluded by them from the radio-carpal joint. It passes also between the four bones of the distal row of the carpus and covers the inner surfaces of the ligaments of the carpo-metacarpal joints and the ligaments of the medial four intermetacarpal articulations.

In some cases the interosseous ligament which connects the base of the third metacarpal to the capitate and hamate bones shuts off the articulation of the hamate bone with the medial two metacarpal bones, and converts the articulation of the hamate bone with the medial two metacarpal bones into a separate segment of the carpo-metacarpal joint.

***Dissection.*—To display the articular surfaces of the carpo-metacarpal articulations, the metacarpus should be detached from the carpus. The interosseous ligaments between the carpal bones of the second row, and also between the bases of the medial four metacarpal bones, can likewise be demonstrated by carrying the knife between the bones, and dividing the ligaments.**

Articular Surfaces.—The base of the metacarpal bone of the index will be seen to be hollowed out for the reception of the lesser multangular bone. On the lateral side it also articulates with the greater multangular bone, and on the medial side with the capitate bone. The base of the third metacarpal rests against the capitate bone alone. The base of the metacarpal bone of the ring finger rests upon the hamate bone, but articulates slightly with the capitate bone also. The fifth metacarpal bone articulates with the hamate bone (Figs. 73, 77, 98, 99, 100).

Movements of the Metacarpal Bones.—The opposed saddle-shaped surfaces of the greater multangular bone and the metacarpal bone of the thumb allow free movement at that joint. Thus the metacarpal bone of the thumb can be moved—(1) dorso-laterally (extension); (2) volarwards and medially (flexion); (3) medially towards the index (adduction); (4) laterally (abduction); (5) medially across the palm towards the little finger (opposition); (6) a combination of the above-mentioned movements, occurring one after the other, constitutes circumduction. The muscles which operate on the thumb are—(1) the two special extensors, brevis and longus, and the abductor pollicis longus, producing extension; (2) the flexor pollicis brevis, the opponens pollicis, and the adductor pollicis, producing flexion and opposition, two movements which are similar in character; (3) the abductor pollicis longus and the abductor pollicis brevis, producing abduction; (4) the adductor pollicis and the first dorsal interosseous muscle, which give rise to adduction.

The metacarpal bones of the index and middle fingers possess very little power of independent movement. The metacarpal bone of the ring finger, and more especially the metacarpal bone of the little finger, are not so tightly bound to the carpus. When the hand is clenched they both move volarwards. The metacarpal bone of the little finger is provided with an opponens muscle, and has a feeble power of moving volarwards and laterally towards the thumb.

The carpo-metacarpal and intermetacarpal joints are supplied by the radial, ulnar and median nerves.

ARTICULATIONES METACARPOPHALANGEÆ ET DIGITORUM (METACARPO-PHALANGEAL AND INTERPHALANGEAL JOINTS).

The ligaments which connect the metacarpal bones with the phalanges and those which connect together the phalanges of adjacent rows are practically similar in character although the joints belong to different groups. The ligaments of each joint are:—

1. Capsula articularis.
2. Lig. accessorium volare.
3. Ligg. collateralia.

Capsula Articularis.—The fibrous stratum of the articular capsule is blended, on the volar aspect, with the accessory volar ligament and at the sides with the collateral ligaments. Dorsally it is absent, and there the synovial stratum of the capsule lies in direct relation with the extensor tendon or tendons which cross the joint.

Ligamentum Accessorium Volare.—The volar accessory ligament is a strong fibrous plate which is firmly attached to the volar aspect of the base of the distal bone of the joint. It extends proximally over the volar aspect of the head of the proximal bone of the joint and is loosely attached to its neck. Its margins are connected with the collateral ligaments and with the fibrous flexor sheath of the finger. The volar surfaces of the volar accessory ligaments of the metacarpo-phalangeal joints are grooved by the flexor tendons and they are connected with one another by the transverse ligament of the heads of the metacarpal bones. Two sesamoid bones are usually developed in the volar accessory ligaments of the metacarpo-phalangeal joint of the thumb and not uncommonly sesamoid bones are found in the corresponding ligaments of other metacarpo-phalangeal joints (Figs. 98, 99).

Dissection.—The extensor tendons should now be raised from the dorsal surfaces of the metacarpo-phalangeal joints. If this is done carefully the dorsal part of the capsule of each joint will be left intact. It is very thin, and consists, practically, of the synovial stratum only, the protection afforded by the extensor tendon rendering the presence of the fibrous stratum unnecessary.

Movements of the Metacarpo-phalangeal Joints.—In each metacarpo-phalangeal joint the single concavity at the proximal end of the first phalanx articulates with the rounded distal extremity or head of the metacarpal bone. The joints are condyloid joints, therefore the movements which occur at them are: (1) flexion, (2) extension, (3) abduction, (4) adduction, (5) circumduction.

During flexion of the fingers the first phalanx travels volarwards with the thick accessory volar ligament upon the head of the metacarpal bone. The *interosseous* and *lumbrical* muscles are chiefly instrumental in producing this movement, but they are aided by the long and short flexors of the digits.

The first phalanges of the fingers, in the movement of extension, can be carried dorsally only to a very slight degree beyond the line of the metacarpal bones. The *extensor communis* and the *special extensors* of the *index* and *little finger* are the muscles which operate in this case.

Abduction and adduction are movements of the first phalanx away from and towards a line prolonged distally through the middle finger, and are seen when the fingers are spread out and again drawn together. The *abductor digiti quinti* and the *dorsal interosseous muscles* act as abductors of the fingers, whilst the *volar interosseous muscles* operate as adductors of the little, ring, and index fingers. In the case of the middle digit, the *second* and *third dorsal interosseous muscles* act alternately as abductors and as adductors. In connection with the movements of abduction and adduction, it should be noticed that in the extended position of the fingers they are very free; but if flexion is induced, the power of separating the fingers becomes more and more restricted, until it becomes lost when the hand is closed. An examination of the collateral ligaments will afford the explanation of this fact. They "are attached so far dorsally on the metacarpal bones, as to be much nearer to their distal ends than to their volar aspects" (Cleland). Consequently, while they are comparatively lax in the extended position of the fingers, the further flexion advances the tighter they become, and in this way they interfere with the lateral movements of the first phalanges.

The first phalanx of the thumb has only a limited range of movement at the metacarpo-phalangeal joint.

Movements of the Interphalangeal Joints. — The interphalangeal joints are hinge joints, therefore the only movements possible are flexion and extension. Flexion of the second phalanges of the fingers is brought about by the flexor sublimis, and of the ungual phalanges by the flexor profundus. Extension of the phalanges at the interphalangeal joints is produced not only by the extensors of the digits but also by the interosseous and lumbrical muscles acting through the extensor expansions, into which they are inserted. The interossei and lumbricals, therefore, flex the first phalanges at the metacarpo-phalangeal joints and extend the second and ungual phalanges at the interphalangeal joints.

In the case of the thumb, the flexor pollicis longus and the extensor pollicis longus operate at the interphalangeal joint.

Some of the metacarpo-phalangeal joints and interphalangeal joints are supplied by the median and some by the ulnar nerve.

PLATE XIX

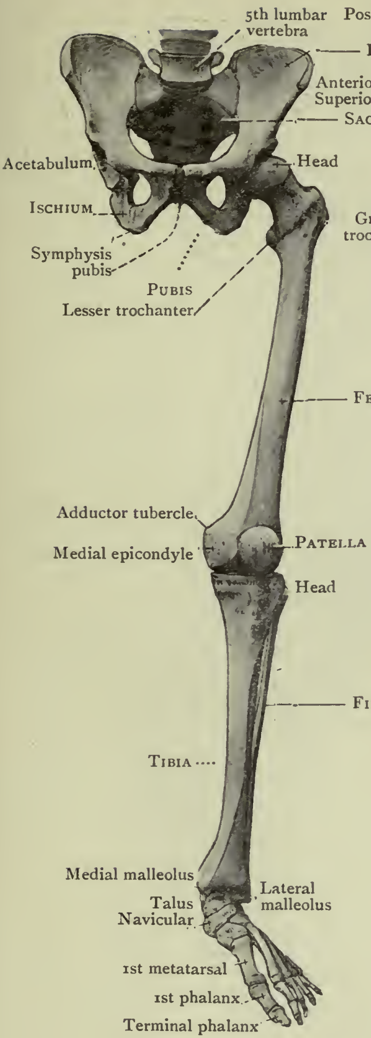


FIG. 101.—Bones of Inferior Extremity.

A. Anterior view.

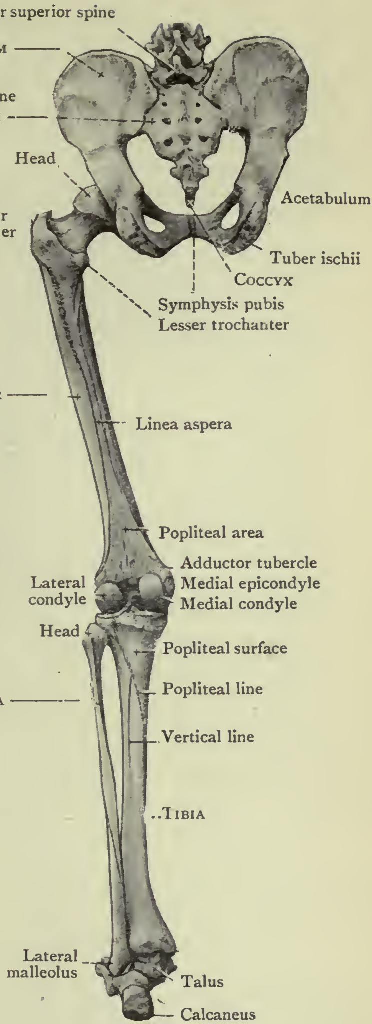


FIG. 102.—Bones of Inferior Extremity.

B. Posterior view.

PLATE XX

FIG. 103.—Radiograph of the Foot of an adult.
(Major T. Rankine.)

INFERIOR EXTREMITY.

Introduction.—Before commencing the dissection the student should be familiar with the bones of the region to be dissected and with the surface markings which indicate the positions of the structures which are to be displayed. He should also possess a general knowledge of the constitution and distribution of a spinal nerve.

The bones of the inferior extremity are: The *os coxæ* or hip bone; the *femur* or thigh bone; the *patella* or knee-cap; the *tibia* and *fibula*, which are the bones of the leg; seven *tarsal* and five *metatarsal bones*, which are the bones of the foot; and fourteen *phalanges*, which are the bones of the toes, three for each except the great toe, which has only two phalanges (Figs. 101, 102, 103).

The *os coxæ* or hip bone lies in the lower part of the trunk. It is jointed posteriorly to the vertebral column, whilst in front it meets its fellow of the opposite side in the median plane, at the *symphysis pubis*. The upper part of the os coxæ is called the ilium. Its highest part forms a curved ridge, the *crest of the ilium*, which is easily felt at the side of the body and is a little below the level of the elbow when the arm hangs by the side. The posterior end of the crest of the ilium is the *posterior superior spine of the ilium*. The anterior end of the crest is the *anterior superior spine of the ilium*.

The lower and posterior part of the os coxæ, upon which the body rests in the sitting posture, is the *ischium*; it is a landmark of importance when the posterior part of the inferior extremity is being dissected.

The lower and front part of the os coxæ is the *pubis*. It meets its fellow of the opposite side, in the median plane, at the symphysis pubis, where it is easily felt. From the upper end of the symphysis pubis a ridge, called the *crest of the pubis*, runs laterally and terminates in a projection termed the *pubic tubercle*.

A faint groove, called the *inguinal sulcus*, extends from the pubic tubercle to the anterior superior spine of the ilium. It indicates the separation between the lower or inguinal region of the trunk and the upper or subinguinal region of the front of the thigh. If pressure is made along the line of the inguinal sulcus, elastic resistance will be felt; it is due to a fibrous band called the *ligamentum inguinale* (Poupartii), which is attached medially to the pubic tubercle and laterally to the anterior superior spine of the ilium.

The finger should now be carried, downwards, along the symphysis pubis to its lower margin, which is at the apex of the *pubic arch*. From its apex the pubic arch must be traced laterally and backwards. It is formed by the rami of the pubis and ischium, and it terminates posteriorly at the *tuber ischiadicum*, which is the protuberant inferior end of the ischial part of the os coxæ. The pubic arch marks the superior boundary of the medial side of the thigh, which is called the *medial femoral region*.

Between the region of the hip and the knee lies the region of the *thigh*, which is the proximal segment of the free part of the inferior extremity. The bone of the thigh is the *femur*. It articulates proximally with the lateral aspect of the os coxæ at the junction of the three segments of that bone, and distally it articulates with the *tibia*, which is one of the bones of the leg, and with the *patella* or knee-cap (Fig. 101).

In the greater part of its extent the femur is deeply embedded amidst the muscles of the hip and thigh and cannot easily be felt, but two parts of its proximal end can be distinguished, viz., the head of the femur and the greater trochanter. If pressure is made below the middle of the inguinal sulcus whilst the thigh is rotated, the rounded *head of the femur* can be distinguished as it moves in the cavity of the hip joint. A more readily felt portion of the proximal end of the femur is the prominent projection called the *greater trochanter*. It lies about ten centimetres (4 inches) below the iliac crest, on a level with the pubic crest, and its highest point is crossed by a line drawn from the anterior superior spine of the ilium to the inferior end of the tuberosity of the ischium. The position of the greater trochanter is indicated, on the surface, by a prominence due to the projection of the bone, and the region of the prominence is the *trochanteric region*. The area between the trochanteric region and the crest of the ilium is the *region of the hip*. The lateral part of the thigh, distal to the trochanteric region, is the *lateral femoral region*.

At the distal end of the anterior part of the thigh is the *regio genu anterior*. In the middle of the region lies the patella. The outline of the patella can be seen as well as felt. When the knee is straight (extended) the extensor muscles of the anterior part of the thigh are relaxed and the patella is freely movable; it lies on the front of the distal end of the femur. As the knee is bent the patella moves off the front of the femur and passes into contact with its distal surface; then the patellar surface on the front of the distal end of the femur can be felt beneath the skin (Figs. 183, 184, 185). The patellar surface is formed by the fused anterior parts of the two condyles which constitute the expanded distal extremity of the femur. The *lateral condyle* lies at the distal end of the lateral femoral area. It is easily palpated, and upon its lateral surface, nearer the posterior than the anterior end, a small rounded eminence can be distinguished; it is the *lateral epicondyle.* The *medial condyle*, which lies at the distal end of the medial femoral region, is more prominent than the lateral condyle. Near its posterior end the large rounded *medial epicondyle* is very obvious to the touch. Above the medial epicondyle, on the upper border of the condyle, is a much smaller and less easily felt prominence, the *adductor tubercle*, so called because the tendon of a muscle called the adductor magnus is attached to it (Figs. 101, 102).

Immediately distal to the condyles of the femur are the *condyles of the tibia*, and below them, in front, is the *tuberosity of the tibia.* Extending from the patella to the tuberosity of the tibia is a thick, broad band called the *ligamentum patellæ*, which is most easily felt when the knee joint is half bent. Immediately distal to the posterior part of the lateral condyle of the femur, on the same horizontal plane as the tuberosity of the tibia, lies the *head of the fibula.* The rounded tendon descending to it, from the thigh, is the tendon of the *biceps femoris.*

Between the knee and the ankle lies the *region of the leg.* In it there are two bones, the *tibia* and the *fibula.* The tibia is the more medial, the more anterior, and much the stronger and more massive of the two bones. It lies immediately beneath the skin and extends the whole way from the knee to the ankle, where it terminates, on the medial side of the ankle, in a visible projection, called the *medial malleolus.* Its anterior border is *the shin*; it is easily traced from the tuberosity of the tibia to the anterior border of the medial malleolus. The proximal end of the tibia articulates by its condyles with the condyles of the femur at the knee joint. Its distal end articulates at the ankle with a bone of the foot called the *talus*. Unlike the tibia, the fibula is deeply situated in the greater part of its length, but its proximal end, the *head* of the fibula, is easily felt immediately below the posterior part of the lateral condyle of the tibia; its distal end, which is called the *lateral malleolus*, is also superficial, and forms a prominent visible projection on the lateral side of the ankle. The fibula takes no part in the formation of the knee joint, for its proximal end reaches only to the lateral condyle of the tibia with which it articulates. Its distal end articulates with the lateral surface of the distal end of the tibia and with the lateral surface of the talus; it enters therefore into the formation of the ankle joint (Figs. 101, 102, 103).

The region below the ankle joint is the foot. In it are seven *tarsal bones*, five *metatarsal bones*, and fourteen *phalanges*. The tarsal bones form the skeleton of the posterior half of the foot; the metatarsal bones are situated in the anterior half of the foot; they are numbered one to five from the medial to the lateral side. The phalanges are in the toes; two in the great toe, and three in each of the other toes.

Each of the tarsal bones is named. The highest of the group, the *talus*, takes part in the formation of the ankle joint, where it lies directly below the tibia, wedged between the malleoli of the tibia and the fibula. It articulates therefore with both the bones of the leg. Its anterior part, *the head*, can be felt below the tibia and in front of the lateral malleolus. The inferior surface of the talus rests upon the *calcaneus*, which projects backwards, behind the malleoli, to form the prominence of the heel. The strong tendon which descends in the back of the leg to the prominence of the heel is the *tendo calcaneus*. In front of the talus, in the medial part of the foot, is the *os naviculare*. Its tuberosity, which is an important landmark, can be felt about 25 mm. (*one inch*) in front of the tip of the medial malleolus (Fig. 103).

In front of the navicular lie the three *cuneiform* bones, first, second, and third from the medial to the lateral side. The first can be felt in front of the tuberosity of the navicular. The other two can be recognised by pressure applied in the dorsum of the foot, but they are not easily distinguished in the undissected foot. In the lateral border of the foot, in front of the calcaneus, is the last of the seven tarsal bones, the *cuboid*. It is difficult to palpate, but immediately in front of it, about seven and a half centimetres anterior to the lateral malleolus, is the prominent posterior end of the fifth metatarsal bone, and the joint between the posterior surface of the cuboid and the anterior end of the calcaneus is about midway between the lateral malleolus and the posterior end of the fifth metatarsal (Fig. 103).

All the metatarsal bones can be felt from the dorsum of the foot, but the large first and the fifth are the most easily distinguishable. The first lies in the medial border of the foot between the first cuneiform and the first phalanx of the great toe. The second and third lie respectively between the second and third cuneiform and the first phalanges of the second and third toes. The fourth and fifth extend from the cuboid behind to the first phalanges of the fourth and fifth toes respectively.

All the above-mentioned points can be verified by the dissector upon his own person whilst he is waiting to commence the dissection of his "part."

Since many students commence dissecting before they have attended lectures or demonstrations on anatomy, they are unacquainted with terms which must be used in the instructions given regarding the dissections which are to be made. Fortunately most of the terms used refer to things which can be seen and felt. They, therefore, are easily understood. There are, however, certain terms used when branches of spinal nerves are under consideration which are not self-explanatory, and it is necessary, therefore, that the student should possess a knowledge of the terms used in connection with spinal nerves before the actual work of dissection is commenced. The following points should be noted: (1) Every spinal nerve is attached to the spinal medulla (spinal cord) by two roots, an *anterior* and a *posterior*; (2) as they are leaving the vertebral canal through an intervertebral foramen the two roots unite to form a *nerve trunk*; (3) immediately after its exit from the intervertebral foramen the trunk breaks up into a *posterior ramus* and an *anterior ramus*, of which except in a few cases the posterior is the smaller; (4) each posterior ramus divides into a *medial branch* and a *lateral branch*; (5) each anterior ramus divides into a *lateral branch* and an *anterior branch* (Fig. 4, p. 6).

Every anterior root consists of nerve fibres passing from nerve cells in the spinal medulla to the fibres of the muscles; they carry motor impulses to the muscles. Each posterior root consists of nerve fibres passing to and from the nerve cells in the ganglion of the root. The fibres of the posterior root convey sensory impulses—pain, heat, cold, etc. The sensory impulses pass through the nerve cells of the ganglion and then onwards to the spinal medulla. The trunk of every spinal nerve, therefore, contains both motor and sensory nerve fibres, and the posterior and anterior rami into which it divides also contain both motor and sensory fibres. The branches of the rami may contain both motor and sensory rami or one or the other only; eventually, however, the peripheral parts of the fibres conveying impulses from the spinal medulla and those conveying impulses to the spinal medulla separate from one another. Every nerve consists of one or more fibres. The fibres which convey impulses from the spinal medulla become the motor nerves which end in muscle fibres, whilst the fibres which convey impulses to the spinal medulla are the sensory nerves, and those sensory nerves which carry impulses from the skin are called cutaneous nerves.

THE THIGH.

On the morning of the fourth day after the subject has been brought into the dissecting room, it is placed upon the table lying upon its back; the pelvis is supported by two blocks, and the inferior extremities are stretched out at full length. In this position it is allowed to remain for five days, and during that period the dissector of the inferior extremity has a very extensive dissection to perform. He has to dissect (1) the anterior region of the thigh, including the *trigonum femorale* and its contents, (2) the medial region of the thigh, including the adductor canal and its contents. With so much work to be completed, within a limited time, he must apportion the five days to the best advantage. During the first day he should dissect the superficial structures of the whole of the anterior and medial aspects of the thigh. During the second and third days he should complete the dissection of the *femoral triangle* and the anterior region of the thigh, and the remainder of the period should be devoted to the dissection of the medial region.

Surface Anatomy.—Before making the preliminary incisions in the skin the dissector must verify the positions of the most

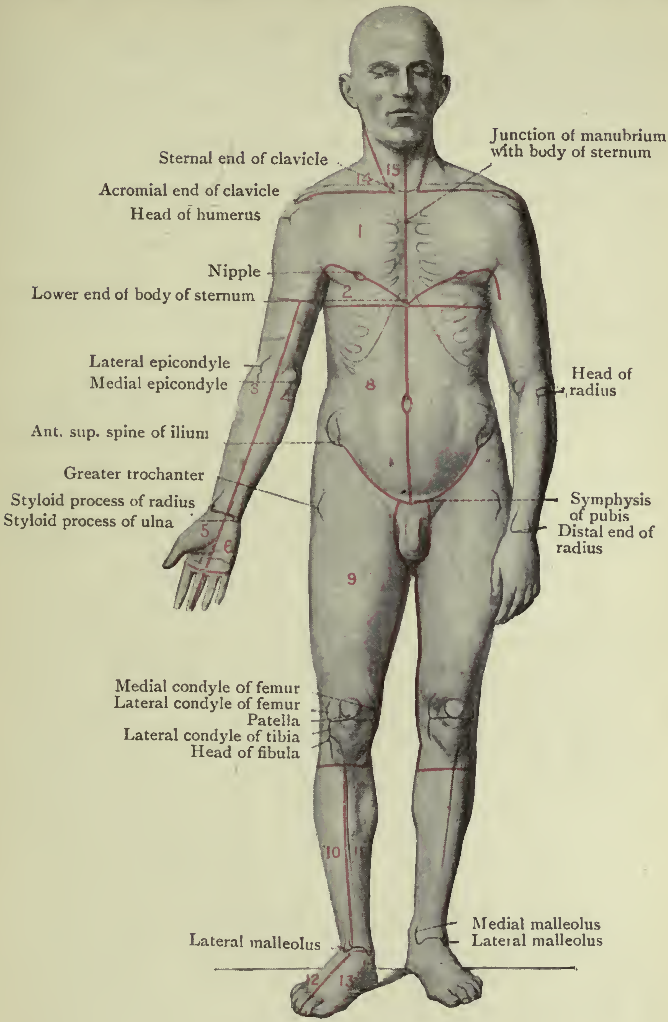


FIG. 104.—Anterior Surface of Body.

prominent landmarks of the anterior, medial, and lateral femoral regions and of the anterior region of the knee.

A faint sulcus at the proximal extremity of the *anterior region* is the boundary line between the *inguinal region* of the abdomen and the *subinguinal region* of the thigh. The resistance felt deep to the sulcus is due to the *ligamentum inguinale*, which is attached, at the lateral and superior end of the sulcus, to the *anterior superior iliac spine*, and, at its inferior and medial end, to the *pubic tubercle*. From the anterior superior iliac spine the *iliac crest* can be traced backwards to the posterior superior spine; from the pubic tubercle the finger should be carried medially, along the *pubic crest*, to the upper end of the *symphysis pubis*. Next, the finger should be passed downwards, along the front of the *symphysis pubis*, to the apex of the *pubic arch* and thence downwards and backwards along the *rami* of the *pubis* and *ischium*, which mark the superior boundary of the *medial femoral region*, to the *tuber ischiadicum*. About ten centimetres below the highest part of the iliac crest, and on the plane of the pubic crest, is the *trochanteric region*, indicated by an eminence due to the prominence of the trochanter major of the femur. Above the trochanteric region, and between it and the iliac crest is the *region of the hip* (*regio coxæ*), and below the trochanteric region is the *lateral femoral region*. At the distal end of the anterior part of the thigh is the *regio genu anterior*. In the centre of the anterior part of the knee lies the *patella* or knee-cap, the outline of which can be seen as well as felt. From the distal end of the patella the *ligamentum patellæ* should be followed to the tuberosity of the tibia.

At the distal end of the lateral region of the thigh the outline of the *lateral condyle* of the *femur* is easily recognised. Directly distal to it is the *lateral condyle* of the *tibia*, and at the distal and posterior part of the latter is the head of the fibula. The tendon which can be traced proximally from the *head* of the *fibula*, on the border line between the lateral and posterior femoral regions, is the tendon of the *biceps femoris*; and the dense, longitudinal band of fascia immediately anterior to the tendon of the biceps is the *ilio-tibial tract* of the fascia lata—a fascial band which is more easily distinguishable in the living than in the dead body.

At the distal end of the medial part of the thigh is the outline of the *medial condyle* of the *femur*, which should be palpated; and immediately distal to it the *medial condyle* of the *tibia* is easily recognised beneath the integument.

The tendons behind the medial condyle of the femur are more easily felt in the living than the dead body; they are the tendons of the *semitendinosus* and *semimembranosus* muscles. The less easily palpated tendon of the *adductor magnus* should be distinguished as it descends to the proximal border of the medial femoral condyle.

The dissector should verify all these points of surface anatomy not only on the dead body but also on the bodies of himself and his friends, and he should examine them repeatedly until he is quite familiar with them both by sight and by touch.

The Anterior Femoral and Medial Femoral Regions and the Anterior Region of the Knee.

Superficial Dissection.—This dissection comprises the examination of the following parts:—

1. Superficial fascia.
2. The great saphenous vein and its tributaries.
3. The superficial external pudendal artery.
4. The superficial epigastric artery.
5. The superficial circumflex iliac artery.
6. Lymph glands and vessels.
7. The fossa ovalis.
8. Cutaneous nerves.
9. The fascia femoris (deep fascia of the thigh).
10. The bursæ patellæ.

Dissection.—Reflection of the Skin.—*Incisions.*—(1) From the anterior superior iliac spine along the line of the inguinal ligament to the symphysis pubis; (2) from the medial extremity of the first incision downwards along the margin of the scrotum, then along the junction of the medial with the posterior aspect of the thigh and across the medial aspect of the knee to the level of the tuberosity of the tibia; (3) from the distal end of the vertical incision transversely across the anterior surface of the leg to its lateral border. The quadrilateral flap of integument, thus mapped out (9, Fig. 104), must be raised carefully from the subjacent superficial fascia and turned laterally, particular care being taken in the region of the knee to avoid injury to the patellar plexus of cutaneous nerves.

To make a *clean incision* through the skin hold the scalpel at right angles to the surface and force the point through the skin into the subjacent soft superficial fascia at the point of commencement of the incision, then incline the blade to an angle of forty-five degrees and, pressing firmly on the back of the blade with the forefinger, draw it along the line of incision. When the opposite end of the incision is reached bring the scalpel to a right angle with the surface again and withdraw it.

To *reflect the skin* take hold of the most convenient angle of the flap—the upper or the lower medial angle in the present dissection—with the forceps, and with the edge of the scalpel detach it from the soft fat beneath.

As soon as the angle selected is sufficiently detached discard the forceps, seize the detached angle between the thumb and forefinger of the left hand, and pull it away from the fat, keeping it stretched and tense; then draw the edge of the scalpel across the skin, at its junction with the fat, from one edge of the flap to the other, always keeping the edge of the knife against the skin. If the work is done properly the leathery-looking deep surface of the skin will be entirely freed from fat, as the flap is reflected, and the superficial nerves and vessels which lie in the fat will not be injured. When the skin is reflected the superficial fascia is exposed.

Superficial Fascia (Panniculus Adiposus).—The superficial fascia is found over the whole surface of the body. It varies in structure in different parts, but in all parts, with the exception of the region of the scrotum, it contains a greater or a smaller amount of yellowish fat, the amount varying not only with the part under consideration but also with the general obesity or thinness of the subject. In some regions, such as the anterior part of the neck and the adjacent part of the chest, reddish muscle fibres are present in the deeper part of the fat; in the scrotum the muscle fibres entirely replace the fat. The fat is interspersed and divided into lobules by lamellæ of denser tissue called *fibrous tissue*, and in the deeper part of the superficial fascia the fibrous tissue becomes more predominant, forming a membrane which is the deeper or membranous layer of the superficial fascia. In the superficial fascia lie the cutaneous vessels and nerves and the deeper parts of the hair follicles and skin glands and the superficial lymph glands. Under the superficial fascia is a more firm membranous layer, the *deep fascia*, surrounding the muscles and deeper parts.

The superficial fascia intervenes therefore between the skin and the deep fascia, and it is attached to both by fibrous strands which pass through the fat. As it lies between the skin and the deep fascia it provides a soft elastic cushion upon which the skin rests, and which, by its elasticity, allows the skin to be moved over the deeper parts. It rounds off the angularities of the deeper parts and forms a bed in which the cutaneous vessels and nerves ramify before they enter the skin.

In most parts of the body the laxity of the superficial fascia allows the skin to be moved freely over the subjacent deep fascia, but in other situations, such as the palms of the hands and the soles of the feet, movement of the skin is limited because the fibrous septa which pass from the skin to the deep fascia are numerous and strong.

In the region now exposed the fat of the superficial fascia is usually abundant. And the membranous deeper layer is well

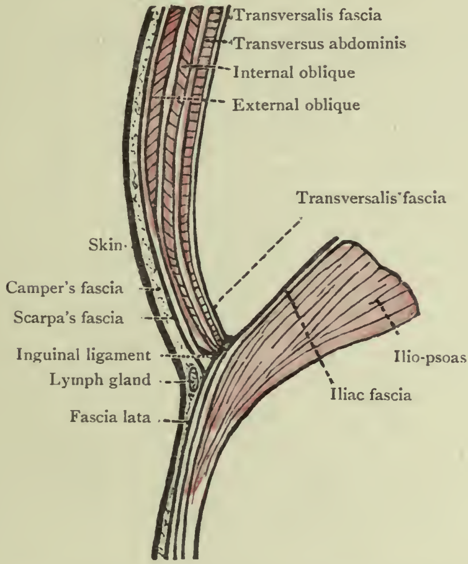


FIG. 105.—Diagram of the Fasciæ and Muscles of the Inguinal and Subinguinal Regions lateral to the Fossa Ovalis.

marked, especially in the proximal part of the region where the lymph glands and the superficial vessels lie between the two layers. Moreover, in the uppermost part of the region the deep membranous layer of the superfical fascia is closely attached to the deep fascia immediately distal to the line of the inguinal ligament, where it is continuous with the corresponding layer of the superficial fascia of the abdominal wall. This is a point of some practical importance, and to demonstrate it the dissectors of the inferior extremity and the abdomen must work in conjunction with each other. A transverse incision must be made through the entire thickness of the superficial fascia on the front of the abdomen from the anterior superior spine of the ilium to the middle line of the body. When the lower edge of the divided fascia is raised its two layers are easily distinguished. The deeper membranous stratum is known as Scarpa's fascia (Fig. 105). Insinuate the fingers behind Scarpa's fascia between it and the pearly-looking tendon of the external oblique muscle. Little resistance will be encountered, for the fascia and the tendon are only connected by some fragile areolar tissue, and the fingers can be passed downwards as far as the inguinal ligament. At or immediately beyond the inguinal ligament the passage of the hand into the thigh is barred by the union of Scarpa's fascia with the deep fascia of the thigh, which is called the *fascia lata*. If the fingers are carried medially along the line of union of the two fasciæ, it will be found that the line of attachment descends across the front of the pubis to the rami of the pubis and ischium, that is, into the *region of the perineum*, which is the interval between the thighs. In the perineum the deep layer of the superficial fascia is no longer called Scarpa's fascia; it becomes Colles' fascia, and has definite connections, which will be studied by the dissector of the abdomen.

If urine or other fluid is effused into the anterior part of the perineum, it cannot get into the medial femoral region because of the attachment of the deep layer of superficial fascia to the rami of the pubis and ischium and to the front of the pubis, but it can ascend, in the areolar tissue between the deep layer of superficial fascia and the deep fascia, to the wall of the abdomen. Having reached the wall of the abdomen it cannot descend into the anterior femoral region because of the connection between the deep layer of the superficial fascia and the fascia lata at or a short distance distal to the inguinal ligament.

Dissection.—The dissection of the contents of the superficial fascia of the subinguinal and anterior femoral regions is one of the most difficult dissections which fall to the lot of the dissector of the inferior extremity. The structures to be displayed are. (1) Four veins—the great saphenous, the superficial external pudendal, the superficial epigastric, and the superficial circumflex iliac. (2) Three arteries—the superficial external pudendal, the superficial epigastric, and the superficial circumflex iliac. (3) The proximal and distal groups of subinguinal lymph glands and the lymph vessels which enter and leave them. The proximal group lies parallel with the inguinal ligament, the distal group lies along the sides of the proximal part of the great saphenous vein. (4) Six nerves—the ilio-inguinal, the lumbo-inguinal, the lateral cutaneous nerve of the thigh, the intermediate cutaneous nerve of the thigh, the medial cutaneous nerve of the thigh, the saphenous nerve. The first three nerves mentioned are derived directly from a plexus of nerves inside the abdomen called the lumbar plexus and the last three are branches of the femoral nerve, which is itself a branch of the lumbar plexus. (5) The fossa ovalis. (6) The patellar bursa, and (7) the deep fascia of the thigh.

Commence by cleaning the great saphenous vein. It is easily found about the mid-length of the thigh, near the medial border. Cut down upon it there and then, with the point and handle of the scalpel, clean away the fascia from its walls, but do not injure its tributaries. Follow the vein, distally, to the posterior border of the medial side of the knee and, proximally, towards a point situated about 4 cm. below and lateral to the pubic tubercle.

As the proximal end of the vein is approached lift it from the bed of superficial fascia in which it lies; insert the handle of the scalpel behind the vein and push it upwards, until it slips through an opening in the fascia lata through which the vein passes on its way to join to the femoral vein. The opening in the fascia lata is the *fossa ovalis*. The layer of the deep fascia which covers the fossa ovalis is called the *cribriform fascia*. The centre of the opening is situated about 35-40 mm. distal and lateral to the pubic tubercle, and its distal margin is always easily demonstrated in the way already indicated. Do not attempt at present to display its other boundaries; they will be dissected later. When the proximal part of the vein is being cleaned a number of the more distal subinguinal lymph glands will be seen, some lying lateral and some medial to the vein. They are rounded or ovoid bodies of greyish or yellowish-pink colour, and they vary greatly in size, some being as small as a pin-head, others as large as a large bean. Connected with them the dissector will find a large number of fine white strands which are the lymph vessels passing to and from the glands. Clean the glands and some of the lymph vessels, but do not disturb them from their positions at present. Then proceed to clean the other superficial blood-vessels. They are the superficial external pudendal, the superficial epigastric, and the superficial circumflex iliac veins and arteries. Begin with the veins which terminate in the great saphenous vein before it passes through the fossa ovalis. Follow them from their terminations towards their commencements, and at the same time clean the accompanying arteries, which are branches of the femoral artery, but avoid injury to the superficial lymph glands which will be met with as the dissection proceeds. Two of the arteries, the superficial external pudendal and the superficial epigastric, emerge through the fossa ovalis: the superficial circumflex iliac artery will be found, as a rule, piercing the deep fascia lateral to the fossa. The lymph glands will be recognised by their firm consistence and their greyish or yellowish-pink colour.

If the subject is a male the dissector will have noted that as the superficial external pudendal vessels pass towards the symphysis pubis they cross superficial to a thick cord, the *funiculus spermaticus*, which emerges from the abdominal wall above the pubic tubercle, and descends across the upper and medial angle of the front of the thigh into the scrotum. In the female the round ligament of the uterus, which is less prominent and less easy to define, lies in the position occupied by the spermatic cord in the male. At the upper part of the lateral margin of the spermatic cord look for the ilio-inguinal nerve which leaves the abdomen with the spermatic cord and sends branches to the upper and medial part of the thigh (Fig. 107).

When the ilio-inguinal nerve has been secured clean the subinguinal lymph glands which lie along the line of the inguinal ligament, and trace some of the fine white lymph vessels which enter and leave them. The subinguinal lymph glands form two groups : a proximal group which lies parallel with the inguinal ligament and a distal group, already displayed, at the sides of the proximal part of the great saphenous vein. Many of them are usually of fairly large size ; indeed they are so large that, as a rule, they can be felt easily through the skin in the living subject. They are recognised in the dissection, as already stated, by their firm consistence and their yellowish-pink colour (Figs. 105, 106).

After the lymph glands have been located and cleaned proceed to define the lateral and superior borders of the fossa ovalis (Fig. 106). Commence at its inferior border, which has already been displayed. Note that as the inferior border, which is called the *inferior cornu*, passes medially it blends with the upper part of the fascia lata which covers the muscles of the medial part of the front of the thigh ; that part of the fascia is known as the pectineal part of the fascia lata to distinguish it from that part of the deep fascia which lies lateral to the fossa ovalis and is called the iliac part of the fascia lata.

The lateral end of the inferior cornu is continuous with the *falciform margin* of the fossa ovalis which curves upwards and medially to terminate in the *superior cornu*. The superior cornu bends medially as the superior margin of the fossa and is attached to the tubercle of the pubis and to the *ligamentum lacunare*, which is an expansion of the medial end of the inguinal ligament. The edge of the scalpel is needed to define the falciform margin and the superior cornu, for both are closely blended with the *cribriform fascia* which extends across the fossa from the falciform margin and superior cornu to the pectineal part of the fascia lata.

Clear away the cribriform fascia, dissecting out the arteries and lymph vessels which pierce it, and display behind it the anterior wall of the *femoral sheath*, a layer of fascia, which surrounds the femoral vessels. Insinuate the handle of the scalpel between the falciform margin and the femoral sheath to demonstrate their independence, then pass the handle of the scalpel behind the medial border of the femoral sheath to demonstrate the fact that the pectineal part of the fascia lata passes behind the femoral sheath.

After the relations of the margins of the fossa ovalis have been defined seek the remaining superficial nerves. Close to the falciform margin of the fossa ovalis find the lumbo-inguinal nerve which pierces the fascia lata a short distance distal to the inguinal ligament. About 50 mm. (two inches) distal to the anterior superior spine of the ilium find the posterior branch of the *lateral cutaneous nerve of the thigh* as it pierces the fascia lata and 50 mm. more distally the anterior branch of the same nerve. About midway between the lateral cutaneous nerve and the great saphenous vein seek for the intermediate cutaneous nerve of the thigh, and along the anterior margin of the great saphenous vein, in the distal third of the thigh, look for the anterior branch of the medial cutaneous nerve of the thigh. Follow the lateral, the intermediate, and the medial cutaneous nerves towards the patella, where they join the *patellar plexus* (Fig. 107). Behind the great saphenous vein, near the knee, look for the posterior branch of the medial cutaneous nerve. Near the distal end of the medial femoral region in front of the great saphenous vein, find the infra-patellar branch of the saphenous nerve and trace it to the patellar plexus, then, at the posterior border of the medial side of the knee, behind the great saphenous vein, find the saphenous nerve itself as it pierces the deep fascia (Fig. 163).

Superficial Inguinal Vessels. — Three small arteries, termed the superficial epigastric, the superficial external pudendal and the superficial circumflex iliac, pierce the deep fascia of the thigh below the inguinal ligament, and radiate from each other for the supply of the lymph glands and integument of the subinguinal and inguinal regions. They all spring from the femoral artery immediately after it enters the thigh.

Art. Pudenda externa superficialis.—The *superficial external pudendal artery* passes forwards, through the fascia cribrosa, which is spread over the fossa ovalis, and runs medially and upwards across the spermatic cord. It supplies the skin of the scrotum and penis or labium majus (Fig. 106).

Art. Epigastrica superficialis.—The *superficial epigastric artery* also pierces the cribriform fascia, turns upwards and leaves the thigh by crossing the inguinal ligament about its middle. It is distributed chiefly to the skin on the front of the abdomen.

Art. Circumflexa ilium superficialis.—The *superficial circumflex iliac artery* pierces the fascia lata lateral to the falciform margin of the fossa ovalis. It is very small, and courses proximally and laterally, along the inguinal ligament, towards the anterior superior spine of the ilium (Fig. 106).

The *veins* which accompany these arteries converge towards the *fossa ovalis* and join the *great saphenous vein* before it pierces the fascia cribrosa.

Lymph Glands and Vessels.—The disposition of the superficial *subinguinal lymph glands* into two groups will now be evident—a proximal *subinguinal group* along the line of the inguinal ligament, immediately distal to the attachment of

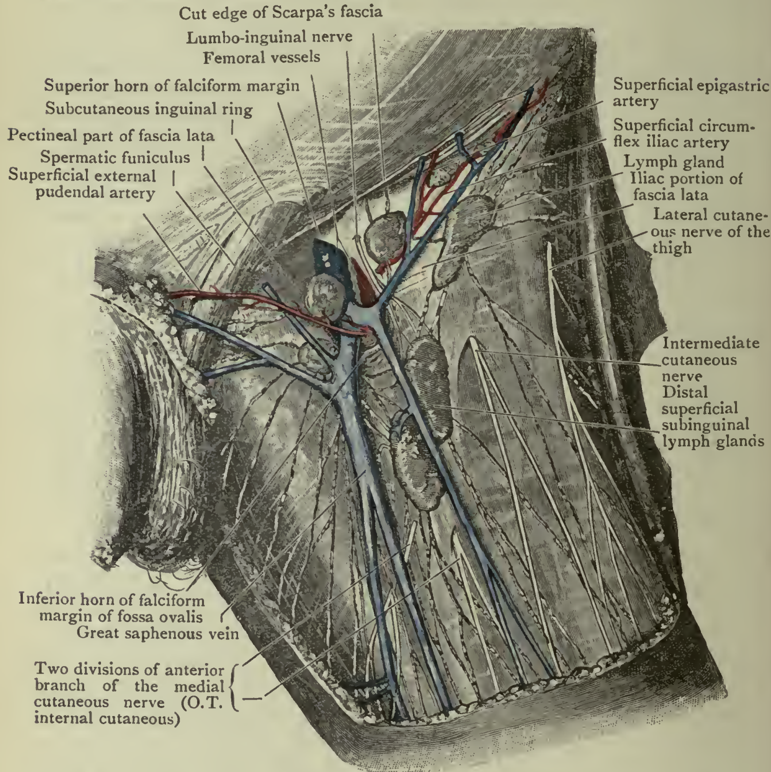


FIG. 106.—Superficial Dissection of the Proximal Part of the Front of the Thigh. The fossa ovalis (O.T. saphenous opening), the superficial lymph glands and vessels of the groin are displayed. The lymph vessels may be recognised by their beaded appearance.

Scarpa's fascia to the fascia lata, and a distal group, which extends for a short distance distally along the line of the great saphenous vein. Both groups are separable into medial and lateral parts.

In a spare subject, or, better still, in a dropsical subject, the general arrangement of the lymph vessels may also be made out. To the subinguinal group of glands proceed the superficial lymph vessels of the lower extremity, and lymph vessels from the external genitals, the perineum, and the lower part of the abdominal wall. These are termed the *afferent vessels.* In addition to them, numerous other vessels connect the glands with one another. The lymph vessels which lead the lymph away from the glands are called the *efferent vessels.* A large number of them pass through the fossa ovalis, others pierce the fascia lata. They join the *deep subinguinal glands* and the external iliac glands, which lie in relation to the femoral and external iliac arteries (Figs. 159, 160).

Fossa Ovalis.—The fossa ovalis is an aperture in the deep fascia of the thigh, through which the great saphenous vein passes before it pierces the femoral sheath and joins the femoral vein. The fossa lies in the upper and medial angle of the front of the thigh, its centre being situated about 37 mm. lateral and distal to the pubic tubercle (Fig. 106). It is bounded, laterally, by a thin curved margin, the *margo falciformis.* The margo falciformis is the medial margin of the more lateral portion of the fascia lata, which, because it is attached to the inguinal ligament superficial to the iliacus muscle, and the anterior part of the iliac crest, is called the *iliac part of the fascia lata.* The proximal end of the margo falciformis is the *superior cornu* (Fig. 106). It turns medially to gain attachment to the pubic tubercle and to the ligamentum lacunare, and so forms the proximal boundary of the fossa. The distal end of the margo falciformis also turns medially, forming the *inferior cornu*, which lies posterior to the upper end of the great saphenous vein, on the medial side of which it terminates by blending with the *pectineal part of the fascia lata*, so called because it ascends superficial to the pectineus muscle to the pectineal line of the pubis (Figs. 106, 113). The manner in which the fascia lata surrounds the muscles of the proximal part of the inferior extremity, so that the iliac portion lies anterior to the femoral sheath and the pectineal portion passes posterior to the sheath, is shown in the section represented in Fig. 113.

The fossa ovalis is closed by the cribriform fascia, a thin stratum of the fascia lata which passes from the falciform margin and the cornua to the pectineal fascia. The cribriform fascia is pierced by the great saphenous vein, the superficial external pudendal and superficial epigastric arteries, and by the efferent lymph vessels from the subinguinal glands on their way to join the deeper subinguinal glands, which lie in the femoral sheath.

Vena Saphena Magna (O.T. **Internal Saphenous Vein**).—The great saphenous vein is the largest superficial vein of the inferior extremity. It commences on the dorsum of the foot, passes anterior to the medial malleolus and ascends through the leg across the medial surface of the distal third of the tibia, and then along the medial margin of the tibia. It enters the area of dissection at present under consideration at the level of the tuberosity of the tibia, ascends in the posterior part of the medial genicular region, then, inclining forwards and laterally, it passes upwards to the fossa ovalis, where it pierces the fascia cribrosa and the femoral sheath, and terminates in the femoral vein. In its course through the thigh it communicates through the deep fascia with the deep veins, and it receives the following tributaries: (1) The *lateral femoral circumflex vein*, from the anterior and lateral parts of the thigh. (2) The *medial femoral circumflex vein*, which commences at the back of the knee where it frequently communicates with the small saphenous vein. The medial femoral circumflex vein runs upwards, curves round the medial side of the thigh and joins the great saphenous vein mid-way between the hip and the knee. (3) The external superficial pudendal vein. (4) The superficial epigastric vein; and (5) the superficial circumflex vein. The last three tributaries join the great saphenous vein immediately before it passes through the fossa ovalis. There are several valves in the interior of the great saphenous vein which help to divide the column of blood into sections, and so reduce the pressure on the walls of the distal part of the vein.

Nervi Cutanei.—The cutaneous nerves met with in the area of the present dissection are:—

$$\text{From the lumbar plexus, }\begin{cases}\text{Ilio-inguinal nerve.}\\ \text{Lumbo-inguinal nerve.}\\ \text{Lateral cutaneous nerve of the thigh.}\end{cases}$$

$$\text{From the femoral nerve, }\begin{cases}\text{Intermediate cutaneous nerve of the thigh.}\\ \text{Medial cutaneous nerve of the thigh.}\\ \text{Saphenous nerve.}\end{cases}$$

They have already been found and cleaned. Now their positions and distributions should be more fully studied.

N. Ilio-inguinalis.—The ilio-inguinal nerve escapes from the subcutaneous inguinal ring (O.T. ext. abdominal) in company with the spermatic funiculus. Most of its branches go either to the scrotum or to the labium majus, but some are distributed to the skin of the adjacent part of the thigh.

N. Lumboinguinalis (O.T. **Crural branch of Genito-crural**).—The lumbo-inguinal nerve pierces the fascia lata a little way distal to the inguinal ligament, and to the lateral side of the falciform margin of the fossa ovalis. It supplies a limited area of skin on the proximal part of the anterior aspect of the thigh. With a little care a communication between this nerve and the intermediate cutaneous nerve of the thigh may be made out (Fig. 106).

N. Femoris Lateralis (O.T. **External Cutaneous**).—The lateral cutaneous nerve of the thigh is distributed on the lateral area of the thigh. It pierces the fascia lata in two parts. Of these, one—the *posterior division*—appears about two inches distal to the anterior superior spine of the ilium, and proceeds posteriorly and distally; some twigs of it may be followed to the lower part of the gluteal region. The *anterior division* comes to the surface about two inches more distally. It is the larger of the two, and has a wide area of distribution. It may extend to the knee. Previous to its division the lateral cutaneous nerve of the thigh lies in a prominent ridge of the fascia lata which descends vertically from the anterior superior spine of the ilium. This must be slit up to expose the nerve.

The intermediate and medial cutaneous nerves belong to the "anterior cutaneous branches of the femoral nerve," but for convenience and for the purposes of more precise description, they are defined by special names.

The **intermediate cutaneous nerve of the thigh** (O.T. *middle cutaneous nerve*), a branch of the femoral nerve, pierces the fascia lata in the middle line of the thigh about three or four inches distal to the inguinal ligament. It appears usually as two branches which perforate the fascia at two points a short distance from each other. Both branches extend distally to the knee, which they reach on its medial aspect.

The **medial cutaneous nerve of the thigh** (O.T. *internal cutaneous nerve*), a branch of the femoral nerve, like the lateral cutaneous nerve of the thigh and the intermediate cutaneous nerve, divides into two portions—an anterior and a posterior—which perforate the deep fascia on the medial aspect of the thigh, and at some distance from each other. The *anterior division* makes its appearance through the fascia lata in the distal third of the thigh, anterior to the great saphenous vein. It descends towards the knee, and its terminal branches turn forwards and laterally to the anterior aspect of the patella. The *posterior division* reaches the surface on the medial side of the knee, behind the great saphenous vein, and proceeds distally to supply the integument on the medial side of the proximal part of the leg. But the main stem of the medial cutaneous nerve, before it divides, also sends a few twigs through the fascia lata to reach the skin on the proximal part of the medial aspect of the thigh. These make their appearance along the line of the great saphenous vein.

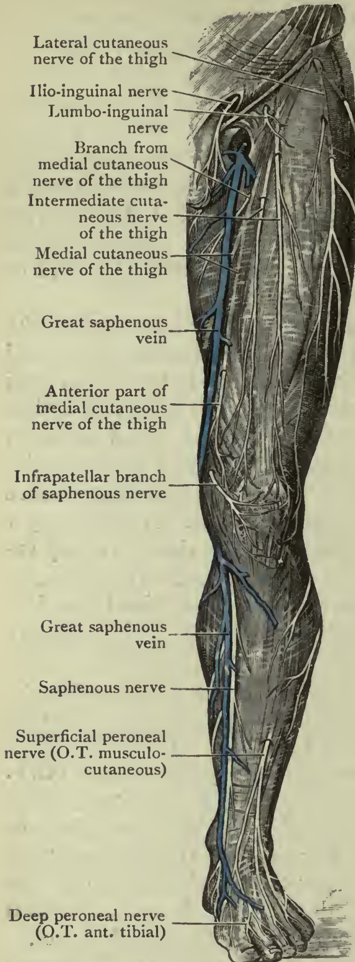


FIG. 107.—Cutaneous Nerves on the Front of the Inferior Extremity.

N. Saphenus (O.T. **Long Saphenous**).—The saphenous nerve becomes cutaneous on the medial side of the knee by perforating the fascia between the tendons of the sartorius and gracilis muscles. The guide to it is the saphenous branch of the *arteria genu suprema*, which descends alongside of it. It follows the course of the great saphenous vein into the leg. Before it pierces the fascia it gives off an infrapatellar branch.

The *infrapatellar branch* pierces the sartorius muscle and the fascia lata on the medial side of the knee, and turns laterally towards the anterior aspect of the joint, distal to the level of the patella (Fig. 107).

Patellar Plexus.—Twigs of four of the cutaneous nerves of the thigh have been traced to the skin of the knee, viz., the anterior division of the lateral cutaneous nerve of the thigh, the intermediate cutaneous, the anterior division of the medial cutaneous, and the saphenous nerve. These nerves communicate with each other and form an interlacement which is situated over the patella, the ligamentum patellæ, and proximal part of the tibia. The interlacement is termed the *patellar plexus.*

On the medial side of the thigh two minute cutaneous nerve twigs sometimes make their appearance which do not belong to any of the above main cutaneous trunks. One appears distal to the ilio-inguinal nerve, and is a twig from the perineal branch of the posterior cutaneous nerve of the thigh; the other pierces the deep fascia at the middle of the medial area of the thigh, and comes from the obturator nerve.

***Dissection.*—After the cutaneous nerves have been cleaned the remains of the superficial fascia must be removed in order that the fascia lata may be studied.**

Fascia Lata.—This is the name which is given to that portion of the general fascial investment of the inferior extremity which clothes the thigh and preserves its figure. Only a portion of it is displayed at present, but the dissector should obtain a general idea of its attachments and parts before proceeding further with the dissection of the anterior femoral region. One of its striking features is the marked difference in strength which it shows in the lateral and medial aspects of the thigh. In the lateral side of the limb it is generally so dense and strong that it appears to be more aponeurotic than fascial in its character, whilst, in addition, a special band called the *tractus ilio-tibialis* is formed in it. The tractus ilio-tibialis extends from the crest of the ilium to the lateral condyle of the tibia and the head of the fibula, and into it are inserted the tensor fasciæ latæ and the greater part of the glutæus maximus muscle; its distal part, therefore, serves as an aponeurotic tendon by means of which the two muscles gain insertion into the lateral condyle of the tibia and the head of the fibula. The ilio-tibial tract serves as a powerful brace, on the lateral aspect of the limb, which, in the erect posture, helps to steady the pelvis and at the same time keep the knee joint firmly extended. On the medial side of the thigh the fascia lata is so exceedingly delicate and thin that the subjacent muscular fibres shine through it, and it is very apt to be removed with the superficial fascia unless care is exercised in the dissection.

Proximally, around the root of the limb, the fascia lata is attached to the inguinal ligament and the bones of the pelvis. Thus, *posteriorly*, it is continuous with the fascia of the buttock, and through that it is fixed to the coccyx, sacrum, and crest of the ilium. On the *lateral side* it is attached to the crest of the ilium; and on the *medial side*, to the body of the pubis, the margin of the pubic arch, and to the tuberosity of the ischium. *Anteriorly*, its proximal attachment is complicated by the presence of the fossa ovalis. That aperture separates the fascia lata into a lateral or iliac portion and a medial or pectineal portion, now known as the *fascia pectinea*. The subdivision extends distally only to the distal border of the fossa ovalis. The *iliac portion* is attached along the whole length of the inguinal ligament. Its medial crescentic margin bounds the fossa ovalis laterally and forms its falciform edge. The cornu superius of that edge blends with the lig. lacunare (O.T. Gimbernat's ligament) an expansion of the medial end of the inguinal ligament. Its inferior cornu joins the pectineal portion of the fascia lata. The *fascia pectinea* clothes the proximal portions of the adductor longus and pectineus muscles. It recedes from the surface as it is traced laterally, passes posterior to the sheath of the femoral vessels, and blends with the capsule of the hip joint, with the deep intermuscular septa, and with the fascia iliaca, which covers the ilio-psoas muscle (Fig. 113). To the medial side of the femoral vessels the fascia pectinea is attached proximally to the pectineal line of the pubic bone. The *fascia cribrosa*, as previously stated, is to be regarded as a thin piece of the fascia lata, stretched across the fossa ovalis. Laterally, it is continuous

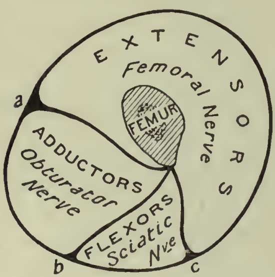


FIG. 108.—Diagram to show the arrangement of the three intermuscular septa and the three osteo-fascial compartments of the thigh. (After Turner.)

a. Medial intermuscular septum.
b. Posterior intermuscular septum.
c. Lateral intermuscular septum.

with the falciform edge of the iliac portion of the fascia; medially, it blends with the front of the fascia pectinea.

In the neighbourhood of the knee the fascia lata is continuous posteriorly with the popliteal fascia, whilst on the sides and front of the joint it is attached to the various bony prominences and to the different tendons in those localities, and it helps to strengthen and support the capsule of the knee joint.

Septa Intermuscularia (Intermuscular Septa).—The fascia lata has other offices to perform besides that of forming a continuous investment for the thigh. From its deep surface processes pass off which penetrate the limb and constitute sheaths for the muscles and other structures. Three of the processes, which are especially strong, form distinct septa or partitions which reach the femur and are attached to the linea aspera on its posterior aspect. These partitions are termed the intermuscular septa, and are so disposed that they intervene between the three great groups of muscles in the thigh. The *lateral intermuscular septum* is placed between the extensor muscles in the anterior area of the thigh and the hamstring muscles in the posterior region; the *medial intermuscular septum* intervenes between the extensor muscles and the adductor muscles in the medial region; whilst the *posterior intermuscular septum*, weak and inconspicuous in comparison with the other two, is interposed between the adductor and the hamstring muscles. The three septal partitions will be disclosed in the subsequent dissection. In the meantime, merely note that the medial and the lateral septa show on the surface of the fascia, in the distal part of the thigh, as white lines. By means of the three septa the thigh is divided into three osteo-fascial compartments, viz., an *anterior*, containing the extensor muscles and the femoral nerve; a *posterior*, holding the hamstrings and the sciatic nerve; and a *medial*, for the adductors with the obturator nerve (Fig. 108).

Bursæ Patellares (Patellar Bursæ).—Several mucous bursæ are situated in the patellar region. Those which lie superficially may be investigated now, and the more deeply placed bursæ should be examined at later stages of the dissection, as opportunity occurs.

The bursæ are—(1) The *subcutaneous prepatellar bursa*, which lies immediately beneath the skin opposite the distal part of the patella. (2) The *subfascial prepatellar bursa*, situated between the fascia lata superficially and the proximal part of the patella and the adjacent part of the tendon of the quadriceps deeply; this bursa may be displayed by an incision made through the fascia lata in the area indicated. (3) The *subtendinous prepatellar bursa*, lying between the superficial fibres of the tendon of the quadriceps and the periosteum of the anterior surface of the patella. (4) The *suprapatellar bursa*. This lies proximal to the patella, behind the tendon of the quadriceps and in front of the distal part of the anterior surface of the femur it usually communicates with the cavity of the knee joint. (5) The *subcutaneous infrapatellar bursa*, placed directly beneath the skin, anterior to the proximal part of the ligamentum patellæ. (6) The *deep infrapatellar bursa*, which is placed between the ligamentum patellæ and the anterior surface of the proximal part of the tibia. The suprapatellar bursa and the deep infrapatellar bursæ are practically always present, but one or more of the subcutaneous and subfascial bursæ may be absent. Not uncommonly a subfascial and an adjacent subcutaneous bursa may communicate through an aperture in the deep fascia. The subcutaneous bursæ are often destroyed during the reflection of the skin, but the deeper bursæ can usually be found, if looked for carefully, in the situations mentioned above.

Deep Dissection of the Anterior and Medial Parts of the Thigh.

In the course of the deep dissection of the anterior and medial femoral regions the following structures will be met with and must be examined :—

1. The femoral sheath.
2. Nervus lumboinguinalis.
3. Nervus cutaneus femoris lateralis.
4. M. sartorius.
5. Nervus femoralis and its rami.
6. Arteria femoralis and its rami.
7. Vena femoralis.
8. M. ilio-psoas.
9. M. quadriceps femoris
   - M. rectus femoris.
   - M. vastus lateralis.
   - M. vastus intermedius.
   - M. vastus medialis.

10. M. articularis genu.
11. M. tensor fasciæ latæ.
12. Deep part of the tractus ilio-tibialis fasciæ latæ.
13. The intermuscular septa, lateral and medial.

Ligament Inguinale (O.T. **Poupart's Ligament**) **and Ligamentum Lacunare** (O.T. **Gimbernat's Ligament**).—Although both of these ligaments belong more to the abdominal wall

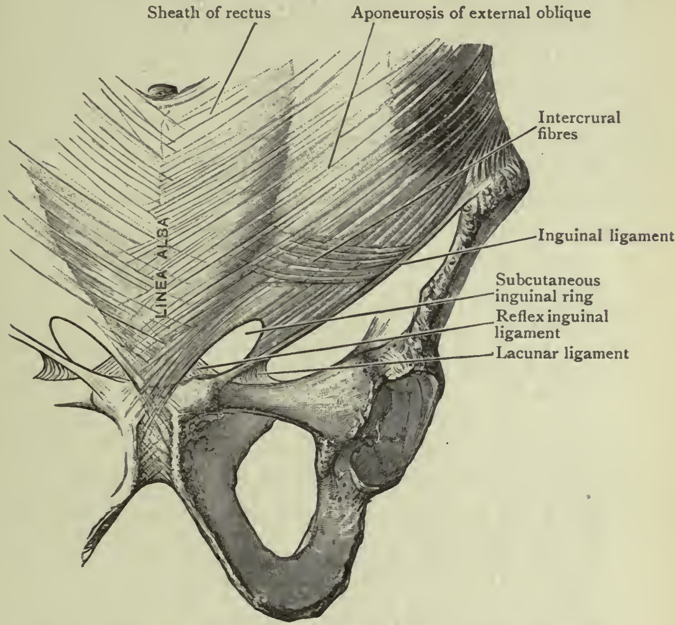


FIG. 109.—Dissection to show the connections of the Inguinal Ligament.

than to the thigh, it is essential that the dissector of the inferior extremity should obtain some knowledge of their connections before he proceeds further with his dissection. The *inguinal ligament* is merely the thickened lower border of the aponeurosis of the external oblique muscle of the abdominal wall folded backwards upon itself. Therefore it presents a rounded surface towards the thigh, and a grooved surface towards the cavity of the abdomen. Its lateral extremity is fixed to the anterior superior spine of the ilium. Medially, it has a double attachment, viz.—(1) to the pubic tubercle, (2) through the medium of the lacunar ligament to the medial part of the pectineal line. The inguinal ligament pursues an oblique course between its iliac and pubic attachments, and at the same time describes a gentle curve, the convexity of which is turned distally. By its distal border it affords attachment to the iliac part of the fascia lata, and when that is divided it loses its curvature.

The *ligamentum lacunare* (O.T. *Gimbernat's ligament*) is a small triangular piece of aponeurosis which occupies the interval between the medial part of the inguinal ligament and the medial inch of the pectineal line—being attached by its margins to both. Its base, which looks laterally, is sharp, crescentic, and free, and abuts against the femoral sheath. The lacunar ligament occupies a very oblique plane; its femoral surface looks distally and laterally, whilst its abdominal surface is directed upwards and medially (Fig. 109).

Dissection.—The exposure of the femoral sheath is the next step in the dissection of the thigh. To display it the *iliac portion* of the fascia lata must be partially reflected. Divide the superior horn of the lateral crescentic margin of the fossa ovalis, and then carry the knife laterally along the lower border of the inguinal ligament, so as to sever the attachment of the fascia lata to that thickened band. The incision should extend to within an inch of the anterior superior spine of the ilium. The piece of fascia marked out by the incision above, and by the lateral free margin of the fossa ovalis medially, must be carefully raised from the subjacent femoral sheath and thrown distally and laterally. On the removal of a little loose fat, the *femoral sheath* will be brought into view as it enters the thigh under the inguinal ligament. Isolate it carefully from adjacent and surrounding parts, by carrying the handle of the knife gently round it as far as possible. Insinuate the handle of the knife, first between the sheath and the *inguinal ligament*, next between the sheath and the *lacunar ligament*, which lies medial to it, and finally behind the sheath along the front of the pectineal fascia. Laterally and posteriorly the sheath is fused with the iliac fascia [1] on the psoas muscle, and in that situation it will be necessary to use the edge of the knife before the sheath can be isolated (Fig. 111).

Femoral Sheath.—The funnel-shaped appearance of the femoral sheath will now be apparent—the wide mouth of the membranous tube is directed upwards towards the abdomen, whilst the narrow distal part gradually closes

[1] Do not confuse the *iliac fascia* with the *iliac part of the fascia lata.* The iliac fascia is a fascia which descends from the abdomen on the anterior surfaces of the psoas and iliacus muscles. The iliac part of the fascia lata is part of the deep fascia of the thigh (see p. 229).

upon the vessels, and fuses with their coats about the level of the distal limit of the fossa ovalis. It should be noticed that the sides of the funnel-shaped sheath do not slope equally towards one another. The lateral border of the sheath is nearly vertical in its direction, whilst the medial wall proceeds very obliquely distally and laterally. If the dissection has been successfully performed, the *lumbo-inguinal nerve* should be seen piercing the lateral wall of the sheath, whilst the great saphenous vein and some lymph vessels perforate its anterior wall. Further, if the subject is spare and the fasciæ well marked, the dissector will in all probability notice that the anterior wall of the sheath, in its proximal part, is strengthened by some transverse fibres which pursue an arched course across it. To those fibres the name of *deep femoral arch* is given, in contradistinction to the term *superficial femoral arch*, which is sometimes applied to the inguinal ligament. The deep femoral arch springs from the deep surface of the inguinal ligament about its middle, then traverses the front of the sheath, and expanding somewhat, is attached by its medial extremity to the pectineal line of the pubic bone behind the lacunar ligament.

Constitution of the Femoral Sheath.—The sources from which the femoral sheath is derived, and the manner in which it is formed, must next be considered. The consideration entails the study of some of the structures concerned in the construction of the abdominal wall, and it is possible that the dissection of the abdomen will not be in a sufficiently advanced state for their examination.

A small portion of the medial part of the interval between the inguinal ligament and the hip bone is filled up by the lacunar ligament. Immediately to the lateral side of the lacunar ligament the femoral vessels, enclosed within the femoral sheath, enter the thigh from the abdominal cavity, whilst still more laterally the interval is occupied by the ilio-psoas muscle. Three nerves also find their way into the thigh through the interval, viz., the lumbo-inguinal nerve, which passes distally in the femoral sheath; the femoral (O.T. anterior crural) nerve, which occupies the interval between the psoas and iliacus muscles; and the lateral cutaneous nerve of the thigh, which runs behind the inguinal ligament, close to its iliac attachment (Fig. 111).

The arrangement of the fascial lining of the abdominal cavity, with reference to this interval of communication between abdomen and thigh, also requires attention. The lower part of the posterior wall of the abdomen, immediately above the thigh, is formed by the iliacus and psoas muscles. These are covered by that part of the fascial lining of the abdomen which receives the name of the *fascia*

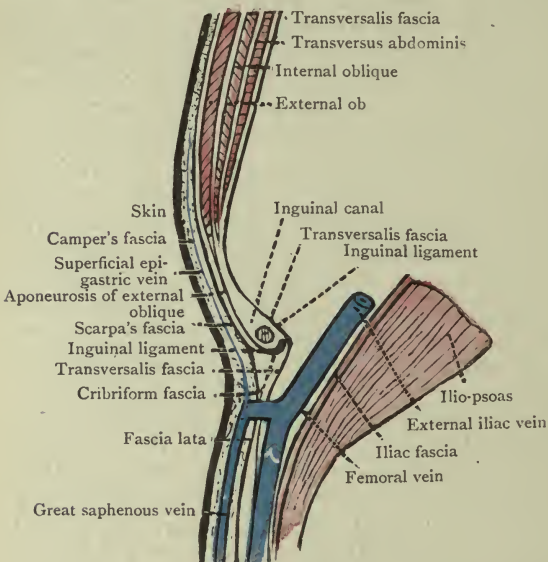


FIG. 110.—Diagram of the Fasciæ and Muscles of the Inguinal and Subinguinal Regions in the line of the Fossa Ovalis.

iliaca.[1] The anterior wall of the abdomen is lined, in like manner, by a portion of the general lining, termed the *fascia transversalis.* To the lateral side of the femoral vessels these two fascial layers become continuous with each other, and at the same time are attached to the back of the inguinal ligament (Fig. 105). It is behind this union that the ilio-psoas, the femoral nerve, and the lateral cutaneous nerve of the thigh are carried distally into the thigh. But the external

[1] The dissector must bear in mind the distinction between the *fascia iliaca* and the *iliac portion* of the *fascia lata.* The former is a part of the general fascial lining of the abdomen, and the latter is a part of the deep fascia of the thigh.

iliac vessels (which become the femoral vessels in the thigh), with the lumbo-inguinal nerve, lie anterior to the fascia iliaca, or, in other words, within the fascial lining of the abdomen, and, as they proceed distally behind the inguinal ligament, they carry with them a funnel-shaped prolongation of the lining, which is the femoral sheath.

The dissector will now readily understand that the *anterior wall* of the sheath is formed of *fascia transversalis* from

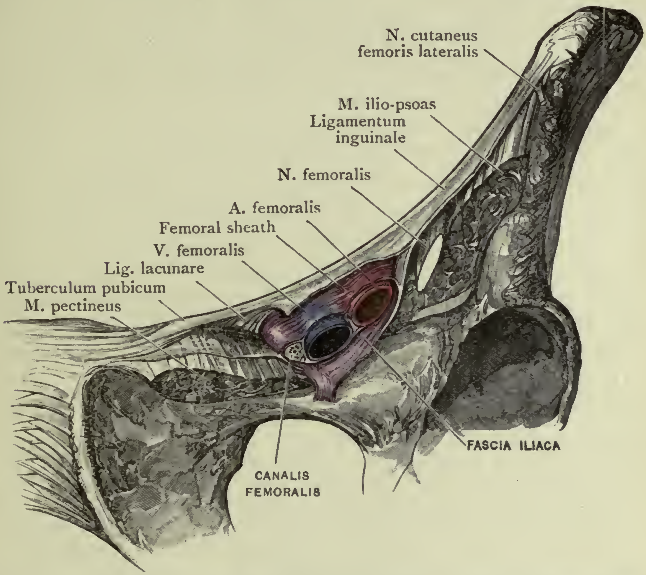


FIG. 111.—Dissection to show the Femoral Sheath and the other Structures which pass between the Inguinal Ligament and the Hip Bone.

the anterior wall of the abdomen, while the *posterior wall* is formed of *fascia iliaca*, prolonged distally, from the posterior abdominal wall (Fig. 110).

Posterior Wall of the Femoral Sheath.—There are still some additional facts relating to the posterior wall of the femoral sheath which require to be mentioned. It is formed, as stated above, by the fascia iliaca; but as that enters the thigh it blends with the lateral part of the (Fig. 113) fascia pectinea, and further, it is firmly fixed in position by certain connections which it establishes in the thigh. Thus, lateral to the femoral sheath, it is prolonged over the ilio-psoas muscle; whilst from its posterior aspect a lamina is given off which passes posterior to that muscle and joins the capsule of the hip joint (Fig. 113).

Dissection.—The femoral sheath must be opened, in order that the arrangement of parts inside may be displayed. Make three vertical and parallel incisions through the anterior wall—one over the femoral artery, which occupies the lateral part of the sheath, another over the femoral vein in the line of the great saphenous vein, and the third about half an inch medial to the second. The first two should begin at the level of the inguinal ligament, and should extend distally for an inch and a half. The most medial of the three incisions should commence at the same level, but should be carried distally only for half an inch or less.

Interior of the Femoral Sheath.—A little dissection will show that the sheath is subdivided, by two antero-posterior partitions, into three compartments. The femoral artery and lumbo-inguinal nerve occupy the *most lateral compartment*; the femoral vein fills up the *intermediate compartment*; whilst in the *most medial compartment* are lodged a little loose areolar tissue, a small lymph gland, and some lymph vessels. This last compartment, from its relation to femoral hernia, has the special name of *femoral canal* applied to it.

Canalis Femoralis.—The boundaries and extent of the femoral canal must be very thoroughly studied. The best way to commence the study is to introduce the little finger into the canal and push it gently upwards. The length of the canal is not nearly so great as that of the other two compartments. Indeed, it is not more than half an inch long. Distally it is closed, and it rapidly diminishes in width proximo-distally. Its proximal aperture lies on the lateral side of the base of the lacunar ligament, and is called the *femoral ring.* It is closed by the closely applied extra-peritoneal fatty tissue of the abdominal wall. The parts which immediately surround the opening can be readily detected with the finger: laterally the *femoral vein*, medially the sharp crescentic base of the *lacunar ligament*, anteriorly the *inguinal ligament*, and posteriorly the *pubic bone* covered by the *pectineus muscle.* The portion of the extra-peritoneal fatty tissue which closes the ring is called the *septum femorale.* On the abdominal surface of the septum femorale is the peritoneal lining of the abdominal cavity, and when examined from above both are seen to be slightly depressed into the opening so as to produce the appearance of a dimple.

Femoral Hernia.—Femoral hernia is the name applied to a pathological condition which consists of the protrusion of some of the contents of the abdominal cavity into the thigh. As they descend they pass behind the inguinal ligament into the *femoral canal* or *most medial compartment* of the femoral sheath. The arrangement of the parts which occupy the interval between the hip bone and the inguinal ligament has been carefully considered, and the dissector should therefore be in a position to understand how the occurrence of such a protrusion is possible. To the medial side of the femoral sheath the interval is closed by the lacunar ligament, which, by its strength and firm connections, constitutes an impassable barrier in that locality. To the lateral side of the femoral sheath a hernial protrusion is equally impossible. There the fascia transversalis on the anterior wall of the abdomen becomes continuous with the fascia iliaca on the posterior wall of the abdomen, and along the line of union both are firmly attached to the inguinal ligament (Fig. 105).

It is in the region of the femoral sheath, then, that femoral hernia takes place. The three compartments of the sheath open above into the abdominal cavity, but there is an essential difference between the three openings. The lateral two, which hold the artery and the vein, are completely filled up by their contents. The femoral canal, or most medial compartment, is not completely filled, for it is wider than is necessary for the passage of the fine lymph vessels which traverse it. Further, its widest part is the upper opening or *femoral ring*. It has been noted that that is wide enough to admit the point of the little finger, and it forms a weak point in the parietes of the abdomen; a source of weakness which is greater in the female than in the male, seeing that in the former the distance between the iliac spine and the pubic tubercle is proportionally greater, and that, in consequence, the femoral ring is wider. Femoral hernia, therefore, is more common in the female (Fig. 105).

When attempts are made to reduce a femoral hernia, it is necessary that the course which the protrusion has taken should be kept constantly before the mind of the operator. In the first instance it passes distally for a short distance in a perpendicular direction. It then turns forwards and bulges through the fossa ovalis. Should it still continue to enlarge, it bends upwards over the inguinal ligament, and pushes its way laterally towards the anterior superior spine of the ilium. The protrusion is thus bent upon itself, and if it is to be reduced successfully it must be made to retrace its steps. In other words, it must be drawn down, and then pushed gently backwards and upwards. The position of the limb during this procedure must be attended to. When the thigh is fully extended and rotated laterally all the fascial structures in the neighbourhood of the femoral canal are rendered tense. When, on the other hand, the limb is flexed at the hip-joint and rotated medially, the upper horn of the margin of the fossa ovalis, and even the lacunar ligament, are relaxed. That, then, is the position in which the limb should be placed during the reduction of the hernia.

As the hernia descends it carries before it, in the form of coverings, the various layers which it meets. First it pushes before it the peritoneum, and that forms the *hernial sac*. The other coverings from within outwards are—(1) the septum femorale; (2) the wall of the femoral sheath; (3) the fascia cribrosa; and lastly, (4) the superficial fascia and skin.

The femoral canal, as already noted, is surrounded by very unyielding structures. Strangulation due to pressure is, therefore, of very common occurrence in cases of femoral hernia. The sharp tense base of the lacunar ligament and the superior cornu of the margin of the fossa ovalis are especially apt to bring about that condition.

Abnormal Obturator Artery.—The account of the surgical anatomy of femoral hernia cannot be complete without mention of the relation which the obturator artery frequently bears to the femoral ring. In two out of every five subjects the obturator artery, on one or on both sides, takes origin from the inferior epigastric artery. In those cases it passes posterior to the pubic bone to gain the obturator sulcus in the upper part

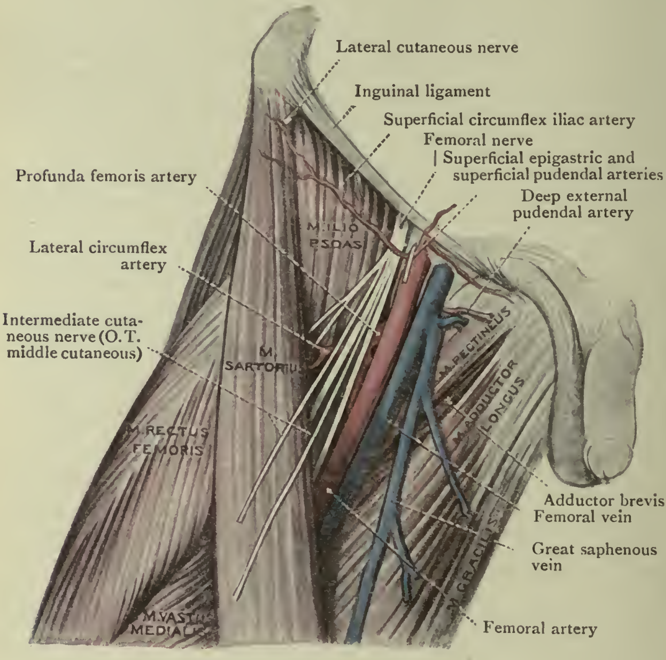


FIG. 112.—Dissection of the Femoral Triangle of the right side

of the obturator foramen, and according to the point at which it arises from the epigastric trunk, it presents different relations to the femoral ring. In the majority of cases it lies in close contact with the external iliac vein and on the lateral side of the femoral ring. In that position it is in no danger of being wounded in operations undertaken for the relief of a strictured femoral hernia. In about thirty-seven per cent., however, of the cases in which it exists, the artery is placed less favourably. In those it either passes medially, across the septum femorale which closes the opening into the femoral canal, or it arches over it and turns posteriorly, on the medial side of the ring, upon the deep aspect of the base of the lacunar ligament. In the latter situation it is in a position of great danger, seeing that it is the base of the lacunar ligament against which the surgeon's knife is generally directed for the relief of strictured femoral hernia.

Dissection.—The boundaries and contents of the femoral triangle, which occupies the proximal third of the anterior part of the thigh, must now be dissected. Commence by cleaning the medial and lateral boundaries. The lateral boundary is formed by the proximal third of the sartorius muscle, and the medial boundary by the medial border of the adductor longus muscle. To clean a muscle properly the following rules must be observed : (1) Keep the muscle tense by bending or straightening the limb or by rotating it. (2) Make all cuts with the scalpel parallel with muscle fibres. (3) Remove the fascia in one continuous layer from one border of the muscle to another. (4) Define very carefully the borders of the muscle.

As the deep fascia is removed the scalpel must cut not only parallel with the muscle fibres but also against them, in order that none of the deep fascia may be left on the muscle.

Clean the sartorius first from its origin on the anterior border of the ilium, below the anterior superior spine, to the point where it crosses the adductor longus at the junction of the proximal and middle thirds of the thigh. Begin at its medial or its lateral border, whichever is more convenient, and take care not to injure the lateral cutaneous nerve of the thigh, which crosses superficial to the muscle near its origin, and the intermediate cutaneous nerve, which either pierces or crosses the muscle near the middle line of the thigh.

Next clean the pectineal fascia from the anterior surface of the adductor longus from the point where the muscle arises from the front of the pubis to the point where it disappears behind the sartorius at the apex of the femoral trigone.

When the medial and lateral boundaries of the trigone have been displayed proceed to the dissection of the femoral nerve and its branches. Place a block under the knee in order to flex the hip-joint and relax the boundaries and contents of the triangle, then follow the intermediate cutaneous nerve upwards to the point where it springs from the front of the trunk of the femoral nerve, next clean the lateral border of the trunk, and inserting the handle of a spare scalpel behind the nerve raise it from the groove between the iliacus and psoas in which it lies. Leave the spare scalpel behind the nerve trunk and clean its various branches so far as they lie in the femoral trigone. Medial to the intermediate cutaneous nerve lies the medial cutaneous nerve of the thigh. It springs from the front of the trunk of the femoral nerve, runs along the lateral border of the femoral sheath and crosses the front of the femoral artery at the apex of the trigone. On a plane posterior to the intermediate and medial cutaneous nerves lie the deeper branches of the femoral nerve. They radiate from the extremity of the trunk of the nerve and are arranged in the following order from above and laterally downwards and medially: the nerve to the rectus femoris, the nerve to the vastus lateralis, the nerve to the vastus intermedius, the nerve to the vastus medialis, and the saphenous nerve. The nerve to the sartorius is usually a branch of the intermediate cutaneous nerve. As the muscular branches are being cleaned take care to avoid injury to the lateral femoral circumflex artery, which passes laterally either behind or between the nerves. After the nerves mentioned have been cleaned pull the trunk of the femoral nerve laterally and secure the nerve to the pectineus, which springs from the medial border of the femoral nerve and passes medially behind the femoral sheath. Follow it as far as possible behind the sheath and keep it in mind during the next stage of the dissection, which includes the removal of the femoral sheath and the cleaning of the femoral artery and its branches and the femoral vein and its tributaries. As many of the branches of the artery as possible should be retained, but small branches to the muscles may be removed if they obstruct the cleaning of the larger vessels. The main trunks of the veins must also be kept and cleaned, but the venæ comites of the smaller arteries should be removed.

Commence with the femoral artery. Trace the superficial branches already displayed back to their origin from the trunk as it lies in the femoral sheath, then raise the trunk of the artery from the sheath, and completely remove that portion of the sheath which surrounded the artery, but do not forget the nerve to the pectineus which lies immediately behind the sheath. As the arterial part of the femoral sheath is removed, find the deep external pudendal artery, which springs from the proximal part of the trunk; then clean the distal part of the femoral artery as far as the apex of the trigone. First clean the medial side, from which no important branches arise. Then clean along the lateral side, from above downwards, and about 50 mm. distal to the inguinal ligament find the large *profunda femoris* branch, which springs from the postero-lateral aspect of the parent trunk. Follow the profunda artery distally and medially behind the femoral and profunda veins and secure its first two branches, the *medial* and the *lateral femoral circumflex arteries*. The medial femoral circumflex artery passes backwards into the deep part of the trigone; the lateral femoral circumflex artery runs laterally, behind or between the muscular branches of the femoral nerve, to the lateral border of the femoral trigone, where it breaks up into ascending, transverse and descending branches. Not uncommonly one or both the femoral circumflex arteries spring from the trunk of the femoral artery, and the dissector must be prepared to meet with such variations.

After the arteries are displayed, clean the femoral and profunda veins, both of which lie posterior to the femoral artery in the distal part of the trigone. As the posterior aspect of the proximal part of the femoral vein is cleaned the nerve to the pectineus must be followed to its termination in the pectineus muscle; then the remaining parts of the pectineal fascia must be removed from the pectineus and adductor longus. As that is done, an interval will come into view between the lower border of the pectineus and the upper border of the adductor longus, in which the superficial division of the obturator nerve should be found. Lastly, the iliac fascia must be cleaned from the surfaces of the iliacus and psoas, and the fat in the angle between the psoas and pectineus must be removed.

Trigonum Femorale.—The femoral triangle is the name given to the triangular hollow which lies in the proximal third of the thigh distal to the inguinal ligament. It possesses a roof or anterior boundary; a floor or posterior boundary; a medial boundary; and a lateral boundary; a base, which is situated proximally at the junction of the thigh with the abdomen; and an apex, which lies distally at the junction of the proximal and middle thirds of the thigh (Fig. 112).

The *lateral boundary* is formed by the medial border of the sartorius muscle as it runs distally and medially across the thigh from the anterior superior spine of the ilium, and, more deeply in the distal part of the triangle, by the medial border of the rectus femoris. The *medial boundary* is constituted by the prominent medial border of the adductor longus, and the two muscles meet below at the front of the apex of the triangle. The *anterior boundary*, or roof, is formed by the iliac part of the fascia lata and the cribriform fascia. It is perforated by the structures which pass through the fascia cribrosa (see p. 229), by the lumbo-inguinal nerve, and the intermediate cutaneous nerve of the thigh, and it is covered by the superficial fascia and skin. The *posterior boundary*, or floor, slopes backwards from the medial and lateral boundaries; the triangle is, therefore, triangular in section as well as in superficial outline. The medial part of the floor is constituted mainly by the anterior surfaces of the adductor longus and the pectineus, but, if an interval exists between the adjacent borders of those two muscles, a part of the anterior surface of the adductor brevis also appears in the medial part of the floor. The lateral part of the floor is formed by the anterior surfaces of the iliacus and the psoas major. The medial femoral circumflex artery passes through the floor, between the adjacent borders of the psoas and the pectineus, and the profunda artery leaves the triangle by passing behind the upper margin of the adductor longus, close to the femur; it is accompanied by the profunda vein. The *apex* is bounded medially by the adductor longus, laterally by the vastus medialis, and anteriorly by the sartorius; through it the femoral vessels, accompanied by the saphenous nerve, pass from the femoral triangle into the adductor canal. The *base* is situated at the junction of the thigh with the abdomen; it is bounded, superficially, by the inguinal ligament; medially, by the lacunar ligament; laterally, by the anterior border of the ilium; and posteriorly, by the pectineus, the psoas major and the iliacus. Through it pass the femoral artery and vein, the deep femoral lymph vessels, the femoral and lumbo-inguinal nerves, and the lateral cutaneous nerve of the thigh.

Arteria Pudenda Externa Profunda. — The deep external pudendal artery is a small twig which arises from the medial side of the femoral artery, distal to the inguinal ligament. It runs medially, upon the pectineus and adductor longus muscles, and, after piercing the fascia lata, ends, according to the sex, in the integument of the scrotum or of the labium majus pudendi.

Dissection.—Before the other contents of the femoral triangle are studied, complete the dissection of the remains of the anterior and medial regions of the thigh and knee.

First clean the remainder of the sartorius as far as its insertion into the tibia, but avoid injury to the nerves which lie in relation with it. The lateral cutaneous nerve of the thigh, which crosses anterior to the muscle near the anterior superior spine of the ilium, and the intermediate cutaneous nerve, which either crosses or pierces it, have already been secured. Below the apex of the femoral triangle the anterior branch of the medial cutaneous nerve crosses superficial to the sartorius, and the posterior branch of the same nerve runs along its posterior border. A short distance proximal to the knee the infrapatellar branch of the saphenous nerve pierces it, and the trunk of the saphenous nerve emerges between its posterior border and the tendon of the gracilis at the medial side of the knee accompanied by the saphenous branch of the arteria genu suprema, which serves as a guide to its position. After the sartorius is displayed, turn to the tensor fasciæ latæ, which lies immediately lateral to the proximal part of the sartorius. At the lateral border of the proximal part of the sartorius the iliac part of the fascia lata splits into two layers. One layer passes superficial to the sartorius, and has been removed to expose the muscle ; the other passes deep to the tensor fasciæ to blend with the tendon of the rectus femoris. Trace the tensor fasciæ to its attachment to the ilio-tibial tract of the fascia lata, into which it is inserted ; then cut through the fascia lata vertically, along the anterior border of the ilio-tibial tract down to the lateral condyle of the tibia. Pull the distal part of the ilio-tibial tract laterally, and demonstrate the lateral intermuscular septum which passes from its deep surface to the lateral supracondylar ridge of the femur. Now clean away the whole of the fascia lata between the tensor fasciæ latæ and the ilio-tibial tract on the lateral side, and the sartorius on the medial side. The muscles which will then be brought into view are the rectus femoris along the middle of the front of the thigh. It will be recognised by the bipennate arrangement of its fibres. Between it and the ilio-tibial tract are parts of the vastus lateralis and vastus intermedius, the latter below the former ; and between it and the sartorius in the distal third of the thigh the distal part of the vastus medialis will be seen.

A short distance proximal to the knee the rectus femoris ends in a tendon which is inserted into the proximal border of the patella, and the vasti end in aponeurotic expansions which are attached to the borders of the patella.

Push the proximal part of the sartorius medially, pull the tensor fasciæ laterally, and find its nerve of supply from the

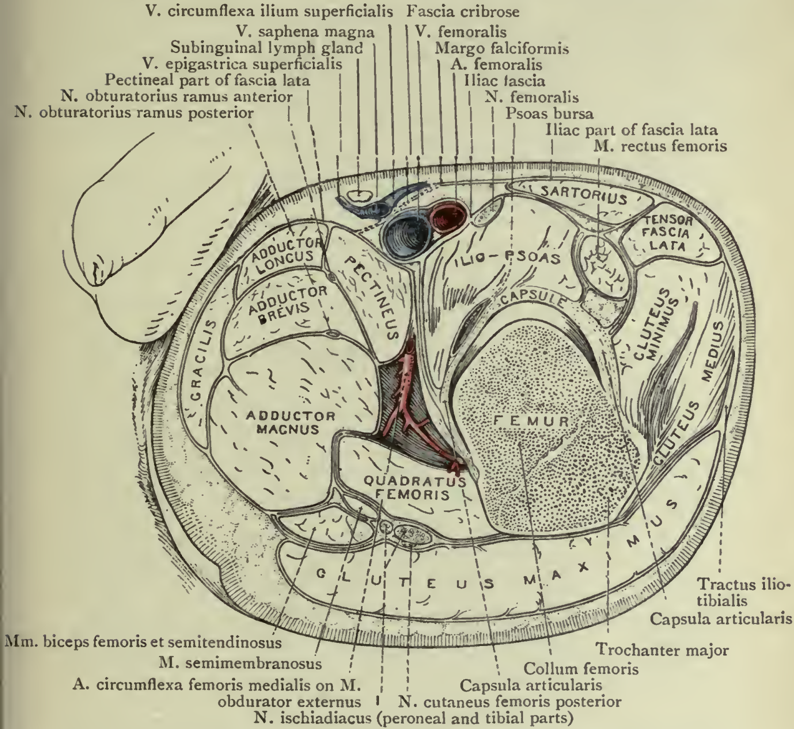


FIG. 113.—Dissection of an oblique transverse Section through upper part of Thigh showing the relation of the Fascia to the Muscles.

superior gluteal nerve. It enters the deep surface of the muscle a little above the middle of its length. When the nerve is secured, follow it backwards till it disappears between the adjacent anterior borders of the glutæus medius and minimus at the anterior margin of the greater trochanter; then clear away the septum of deep fascia which passes deep to the tensor fasciæ to blend medially with the tendon of the rectus femoris and laterally with the front of the capsule of the hip joint. As the deep part of the septum is removed, find and clean the ascending branch of the lateral femoral circumflex artery, and look for the twig which springs from it and pierces the fibrous capsule of the joint; then clean the straight head of the rectus femoris to its origin from the anterior inferior spine of the ilium, and follow the reflected tendon backwards to the upper border of the acetabulum where it is embedded in the fibrous stratum of the capsule of the hip joint. Note that the interval between the tensor fasciæ and the sartorius is a path by which the surgeon gets easy access to the front of the hip joint without endangering any structures of importance. Clean and define the anterior borders of the glutæus medius and minimus. The nerve to the tensor fasciæ emerges between the closely apposed borders of the two muscles and indicates the line of separation. Not uncommonly the anterior border of the medius is blended with the deep surface of the tensor fasciæ; if that is the case, separate the two muscles with the scalpel.

Turn now to the medial side of the middle third of the thigh, and pull the sartorius laterally. Posterior to it there is an angular interval bounded laterally by the vastus medialis and medially by the adductor longus above and the adductor magnus below. The interval is crossed by a strong layer of fascia which forms the roof of the *adductor canal* (Hunter's) (Figs. 114, 115). On the fascia lies some loose areolar tissue in which is embedded the subsartorial plexus of nerves. The plexus is not always easily demonstrable, but if the dissector is successful he will find that it is formed by interlacing twigs from the medial cutaneous, the saphenous, and the obturator nerves. Clean the plexus and areolar tissue away and clean the fascial roof of the canal. It is attached laterally to the vastus medialis, and medially to the adductors magnus and longus. Its proximal extremity fades away indefinitely at the apex of the femoral triangle, but at its distal end it terminates in a sharp crescentic border which extends from the vastus medialis to the adductor magnus, at the junction of the middle and distal thirds of the thigh. The saphenous nerve accompanied by the saphenous branch of the arteria genu suprema will be seen emerging from the canal behind the distal crescentic border of the fascial roof. To display the contents of the canal, divide the fascial roof by a vertical incision extending from its proximal to its distal end, and then clean the contents, which are the femoral artery, the femoral vein, the saphenous nerve, and the nerve to the vastus medialis.

M. Sartorius. — The sartorius is a long slender muscle, which arises from the anterior superior spine of the ilium and the upper part of the notch on the anterior border of the bone immediately below the spine. It crosses the front of the proximal third of the thigh obliquely, and, gaining the medial side of the limb, it takes a nearly straight course distally to a point beyond the medial prominence of the knee. There it turns forwards, and ends in a thin, expanded aponeurotic tendon, which is inserted into the medial surface of the body of the tibia, posterior to the tuberosity (Fig. 139, p. 322). By its distal border the tendon is connected with the fascia of the leg, whilst by its proximal border it is joined to the capsule of the knee joint.

In its proximal, oblique part, the sartorius muscle forms the lateral boundary of the femoral triangle, and lies anterior to

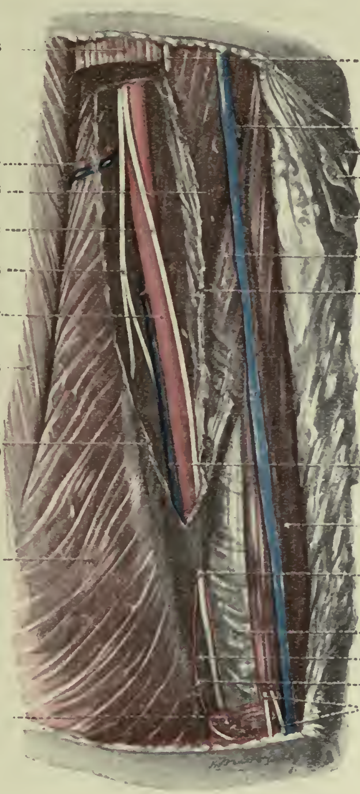


FIG. 114.—Dissection of the Adductor Canal (Hunter's) in the right lower limb. A portion of the Sartorius has been removed.

the iliacus, the rectus femoris, and the adductor longus muscles. More distally, it is placed anterior to the femoral vessels as far as an opening in the adductor magnus through which they pass into the popliteal fossa. At its insertion its expanded tendon lies anterior and superficial to the tendons of insertion of the gracilis and semitendinosus, but is separated from them by a bursa. The sartorius is supplied by the *femoral nerve.* It is a flexor of the knee and a medial rotator of the leg, a flexor of the hip joint and a lateral rotator of the thigh.

Canalis Adductorius Hunteri (O.T. **Hunter's Canal**).—When the femoral artery leaves the femoral triangle it is continued distally, in the medial region of the thigh, in a deep furrow, which is bounded anteriorly by the vastus medialis muscle, and posteriorly by the fascia on the anterior surfaces of the adductor longus and magnus muscles, which is the medial intermuscular septum of the thigh. At its proximal end this furrow is continuous with the deeper, wider, and more apparent

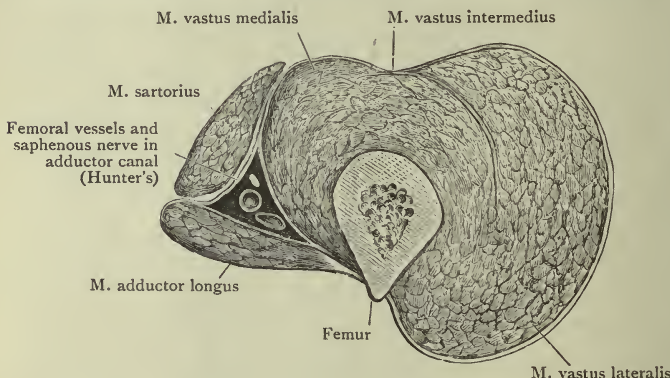


FIG. 115.—Transverse Section through the Adductor Canal.

hollow, which has been described as the femoral triangle. Further, the furrow is converted into a canal, triangular on transverse section, by a strong fibrous membrane which stretches across it, and upon the surface of which the sartorius muscle is placed (Fig. 115). The tunnel thus formed is called the *adductor canal* (Hunter's). The fibrous expansion which roofs in the canal stretches from the adductor longus and the adductor magnus posteriorly to the vastus medialis anteriorly. When it is traced proximally, it is seen to become thin and ill-defined as it approaches the femoral triangle; when traced in the opposite direction, however, it becomes dense and strong, and below the opening in the adductor magnus, at the distal end of the canal, it presents a thick, sharply defined margin. In its distal part the posterior wall of the canal, where it is formed by the adductor magnus, presents a deficiency or aperture which leads backwards into the popliteal fossa. The appearance and construction of this aperture will be studied at a later stage. It is called *the hiatus tendineus* or *opening in the adductor magnus.*

The femoral vessels and the saphenous nerve traverse the adductor canal. Whilst the femoral artery is in the canal it gives off some muscular twigs and the arteria genu suprema. The femoral vessels leave the canal at its distal end by inclining posteriorly through the opening in the adductor magnus and entering the popliteal fossa. The saphenous nerve, accompanied by the saphenous branch of the arteria genu suprema, escape from the canal by passing under cover of the distal thickened margin of the fibrous expansion which forms the roof. They can be seen in the present stage of the dissection in that situation.

Arteria Femoralis (O.T. Femoral Artery, Common and Superficial).—By the dissections which have been made the whole of the femoral artery has been exposed, and its course and relations may now be studied. It is the direct continuation of the external iliac artery and is the great arterial trunk of the inferior extremity. It begins at the inguinal ligament, behind which it enters the thigh, and it extends, distally, through the proximal two-thirds of the thigh to the opening in the adductor magnus, through which it passes into the popliteal fossa and becomes the popliteal artery. The course of the femoral artery may be marked on the surface, when the thigh is slightly flexed, abducted and rotated laterally, by a line drawn from a point situated midway between the anterior superior spine of the ilium and the symphysis pubis to the adductor tubercle on the medial condyle of the femur.

The relations which the artery bears to the femur are important. As it enters the femoral triangle it leaves the brim of the pelvis and lies in front of the medial part of the head of the femur, from which it is separated by the psoas major muscle. Although its relation to the head of the femur is fairly intimate, that situation should not be chosen for applying compression, for, on account of the mobility of the head of the bone, the vessel is apt to slip from under the fingers. It is much safer to compress it against the hip bone. Distal to the head of the femur, during the remainder of its course through the femoral triangle, the artery is not in direct relation to the bone. It crosses anterior to the angular interval between the neck and body of the femur. Towards the apex of the triangle, however, it comes into relation with the medial side of the body of the femur, and that position it holds to its termination.

In the triangle the proximal part of the femoral artery is enveloped by the femoral sheath, and is separated from the surface by the skin, superficial fascia, and deep fascia; whilst more distally it is crossed by the medial cutaneous branch (O.T. internal cutaneous) of the femoral nerve, which runs along the medial border of the sartorius muscle. The extent of the artery which lies in the femoral triangle varies with the development of the sartorius muscle, but as a rule it measures from 7.5 to 10 cm. At the apex of the triangle the artery enters the adductor canal.

In the adductor canal the artery lies more deeply, and is separated from the surface not only by the skin, superficial fascia and deep fascia, but also by the sartorius muscle, the sub-sartorial plexus of nerves, and the fascial roof of the canal, and, at the mid-length of the canal, the saphenous nerve crosses the front of the artery from the lateral to the medial side.

Lateral to the artery, in the proximal part of the femoral trigone, is the femoral nerve. The two are not, however, in close contact, for the lateral part of the femoral sheath and the projecting lateral border of the psoas major muscle intervene between them. In the distal part of the triangle the medial cutaneous nerve lies lateral to the artery, but it is replaced, in the proximal half of the adductor canal, by the saphenous nerve, and beyond the middle of the adductor canal, where the saphenous nerve passes to the front of the artery, the artery itself is in relation, on its lateral side, with the vastus medialis muscle.

In the proximal part of the femoral triangle the femoral vein lies medial to the artery, separated from it by the lateral septum of the femoral sheath. Beyond the femoral sheath the vein passes behind the artery and no other structure forms a direct medial relation till the distal part of the adductor canal is reached, where the saphenous nerve lies along the medial face of the distal part of the artery.

Posterior to the artery are the psoas, the pectineus, the adductor longus and the adductor magnus muscles, but the artery is separated from the psoas by the posterior part of the femoral sheath and the nerve to the pectineus, and from the pectineus by fatty areolar tissue in which lie the femoral vein, which has passed from the medial to the posterior aspect of the artery, the profunda vein and the profunda artery, in that order from before backwards. It is separated from the adductors longus and magnus by the femoral vein alone, because the profunda vein and artery dip backwards between the pectineus and the adductor longus and descend behind the latter muscle.

The branches which the artery gives off in the femoral triangle have already been enumerated, and some of them have been followed to their terminations, whilst others will be traced in later dissections. The branches which arise in the adductor canal are muscular twigs which supply adjacent muscles and the arteria genu suprema.

Arteria Genu Suprema (O.T. **Anastomotic**).—The arteria genu suprema springs from the femoral trunk, a short distance proximal to the point where the latter enters the popliteal fossa by passing through the opening in the adductor magnus. Almost immediately after its origin it divides into a saphenous and a musculo-articular branch: frequently, the two branches have separate origins from the femoral artery.

The *saphenous branch* accompanies the saphenous nerve; it leaves the adductor canal by passing under cover of the distal border of the fibrous expansion which is stretched over the canal. On the medial side of the knee it appears between the gracilis and sartorius, and it ends in branches to the integument on the medial aspect of the proximal part of the leg.

The *musculo-articular branch* enters the substance of the vastus medialis and proceeds distally, anterior to the tendon of the adductor magnus. It gives some twigs to the vastus medialis and others which spread out over the proximal and medial aspects of the knee joint, and it anastomoses with branches of the medial genicular arteries. One well-marked branch runs laterally, proximal to the patella, to anastomose with the lateral superior genicular artery.

Vena Femoralis.—The femoral vein is the direct proximal continuation of the popliteal vein. It begins at the opening in the adductor magnus, through which it enters the adductor canal; its proximal end passes behind the inguinal ligament and becomes continuous with the external iliac vein. It accompanies the femoral artery, but the relations of the two vessels to each other differ at different stages of their course. In the distal part of the adductor canal the vein lies posterior to the artery and on its lateral side, but it inclines medially as it ascends, and in the proximal part of the thigh it lies on the medial side of the artery and on the same plane. The crossing from one side to the other takes place posterior to the artery and is very gradual, so that for a considerable distance the femoral vein lies directly posterior to the femoral artery. For a distance of two inches distal to the inguinal ligament it is enclosed within the femoral sheath, of which it occupies the intermediate compartment.

As it ascends in the thigh the femoral vein receives tributaries which, for the most part, correspond with the branches of the femoral artery. At the fossa ovalis it is joined by the great saphenous vein. The dissector should slit the femoral vein open with the scissors. Several valves will then be seen. One is almost invariably found immediately proximal to the entrance of the vein which corresponds to the profunda artery.

Nervus Femoralis (O.T. **Anterior Crural**).—The femoral nerve is a large nerve which arises, within the abdomen, from the lumbar plexus. It enters the thigh by passing distally in the interval between the psoas and iliacus muscles, posterior to the inguinal ligament and the fascia iliaca. In the proximal part of the thigh it lies to the lateral side of the femoral artery, and is separated from it by a small portion of the psoas major muscle and the femoral sheath (Fig. 111). A short distance below the inguinal ligament it divides into an anterior and a posterior portion; they at once resolve themselves into a large number of cutaneous and muscular branches which are named in the following list:—

Anterior division,	Rami musculares,	To the pectineus.
		,, sartorius.
	Rami cutanei anteriores,	Intermediate cutaneous nerve of the thigh.
		Medial cutaneous nerve of the thigh.

Posterior division,	Rami musculares,	To the rectus femoris.
		,, vastus medialis.
		,, vastus lateralis.
		,, vastus intermedius.
		,, m. articularis genu.
	Ramus cutaneus,	Saphenous nerve.
	Rami articulares.	

With the exception of the saphenous nerve, which is distributed upon the medial side of the leg and foot, the distribution of the cutaneous branches of the femoral nerve has been already examined (p. 230).

The *nerve to the pectineus* arises a short distance distal to the inguinal ligament and turns medially, posterior to the femoral vessels, to reach its destination. The *branches to the sartorius* are two or three in number. As a rule, they take origin in common with the intermediate cutaneous nerve.

The *intermediate cutaneous nerve* (O.T. *middle cutaneous*) sometimes pierces the proximal border of the sartorius. It divides into two branches which perforate the fascia lata about three or four inches distal to the inguinal ligament.

The *medial cutaneous nerve* (O.T. *internal cutaneous*) inclines distally and medially, crosses anterior to the femoral artery at the apex of the femoral triangle, and divides into an anterior and a posterior portion, which become superficial, at different levels, on the medial side of the limb. From the trunk of the nerve a few cutaneous twigs are given to the skin over the proximal and medial parts of the thigh. The *anterior branch* crosses the sartorius muscle and makes its appearance through the fascia lata in the distal part of the thigh, a short distance anterior to the great saphenous vein. The *posterior branch* runs distally, along the posterior border of the sartorius, and pierces the deep fascia on the medial side of the knee, behind the sartorius and the saphenous nerve.

A short distance distal to the middle of the thigh the posterior branch of the medial cutaneous nerve forms, with filaments from the obturator nerve and the saphenous nerve, a plexiform interlacement, the *sub-sartorial plexus*, which is placed deep to the sartorius muscle as it lies over the adductor canal (Hunter's). The twig from the obturator nerve appears at the medial border of the adductor longus.

The *saphenous nerve* (O.T. *internal saphenous nerve*) is the longest branch of the femoral nerve. It springs from the posterior division of that nerve and runs distally at first on the lateral side of the femoral artery. In the adductor canal it crosses in front of the femoral artery. It emerges from the distal end of the canal by passing under cover of the thickened border of the fibrous expansion which stretches between the vastus medialis and the adductor muscles, and, accompanied by the saphenous branch of the arteria genu suprema, it escapes from under cover of the sartorius, passing between it and the tendon of the gracilis. Then it pierces the deep fascia at the medial side of the knee. After it quits the adductor canal it gives off the *infrapatellar branch*, which pierces the sartorius and appears on the surface of the fascia lata on the medial side of the knee (Fig. 107).

Several large branches of the posterior part of the femoral nerve enter the four segments which compose the great quadriceps extensor muscle of the thigh. From some of the branches, articular filaments are given either to the hip or to the knee joint.

The *branch to the rectus femoris* sinks into the deep surface of that muscle. It supplies an articular twig to the hip joint. The large *branch to the vastus medialis* accompanies the saphenous nerve and enters the proximal part of the adductor canal. It can readily be distinguished, because it sinks into the medial aspect of the vastus medialis, about the middle of the thigh. In the substance of the muscle it extends distally, and near the knee joins the articular branch of the arteria genu suprema. It gives an articular nerve to the synovial layer of the knee joint. The *nerve to the vastus lateralis* is associated with the descending branch of the lateral circumflex artery. Very frequently it gives an articular twig to the knee joint. The *nerves to the vastus intermedius* are two or three in number, and they sink into its anterior surface. The most medial of them is a long slender nerve, which can be traced distally, under the anterior border of the vastus medialis, to the articular muscle of the knee. Its terminal twigs are given to the synovial stratum of the knee joint.

Thus, one filament from the femoral nerve goes to the hip joint; two, and frequently three, filaments go to the knee joint.

Tractus Ilio-tibialis of the Fascia Lata (O.T. **Ilio-tibial Band**).—The thick band of fascia lata on the lateral aspect of the thigh which receives this name should now be examined, and its connections ascertained. It is attached superiorly to the tubercle on the outer lip of the crest of the ilium, behind the tensor fasciæ latæ, and, inferiorly, to the lateral condyle of the tibia and the head of the fibula. On the lateral condyle of the tibia it is attached to a prominent ridge which extends from the fibular facet forwards and downwards to the tuberosity. It is covered by skin and superficial fascia, and from above downwards it lies superficial to part of the glutæus medius, the greater trochanter, the vastus lateralis, the lower lateral part of the vastus intermedius, the lateral condyle of the femur, and the lateral border of the knee joint. Two muscles are inserted into it: the glutæus maximus posteriorly at the level of the greater trochanter, and the tensor fasciæ anteriorly in the proximal third of the thigh. Above the insertion of the glutæus maximus its posterior border is continuous with the thick fascia on the superficial surface of the glutæus medius, and its anterior border splits into a superficial and a deep lamella, both of which have already been cleared away; for the superficial lamella covered the superficial surface of the tensor fasciæ, and the deep lamella is the layer on the deep surface of the tensor fasciæ which extends medially to become continuous with the tendon of the rectus femoris and the front of the capsule of the hip joint (see p. 248). In the distal half of the thigh its deep surface is attached to the lateral supracondylar ridge of the femur and to the lower part of the linea aspera by the lateral intermuscular septum.

M. Tensor Fasciæ Latæ (O.T. Tensor Fasciæ Femoris).—The tensor of the fascia lata is a small muscle which is placed on the lateral and anterior aspect of the proximal third of the thigh. It lies between the two lamellæ of the proximal part of the ilio-tibial tract, in the interval between the sartorius muscle anteriorly and the glutæus medius muscle posteriorly. Its nerve of supply, a branch of the superior gluteal nerve which enters the deep surface of the muscle a little above the middle of its length, has already been exposed (p. 249).

The *tensor fasciæ latæ* arises from a small portion of the anterior part of the outer lip of the crest of the ilium; from the upper part of the margin of the notch below the anterior superior spine of the ilium; and by some fibres from the fascia covering the glutæus medius. It extends distally, with a slight inclination posteriorly, and is inserted into the *ilio-tibial tract of the fascia lata.*

Arteria Circumflexa Femoris Lateralis (O.T. **External Circumflex Artery).**—The lateral femoral circumflex artery is the largest branch which springs from the profunda femoris artery. It arises near the origin of the latter, and runs laterally, between the divisions of the femoral nerve and then

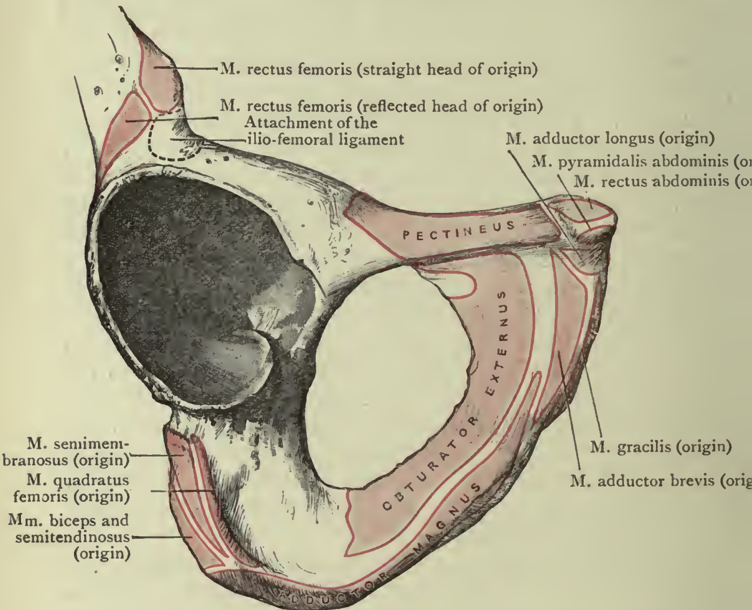


FIG. 116.—External Surface of the Pubis and Ischium, with the Attachments of Muscles mapped out.

under cover of the sartorius, to the deep surface of the rectus femoris muscle, where it ends by dividing into ascending, transverse, and descending branches.

The *ascending branch* reaches the external surface of the upper part of the ilium by ascending along the inter-trochanteric line of the femur under cover of the deep surface of the tensor fasciæ latæ. As it ascends it gives a branch to the hip joint, twigs to the adjacent muscles, and its terminal twigs anastomose with branches of the superior gluteal artery.

The *transverse branch* is of small size. It passes to the deep surface of the vastus lateralis, reaches the posterior part of the thigh, and inosculates with the medial femoral circumflex artery and the first perforating artery. The *descending branch* gives twigs to the vastus intermedius and rectus femoris, and one long branch, which may be traced distally, amid the fibres of the vastus lateralis, to the knee, where it anastomoses with the lateral superior genicular artery.

Dissection.—Divide the ilio-tibial tract of the fascia lata, distal to the tensor fasciæ latæ, in order to obtain a better demonstration of the limits of the lateral intermuscular septum and a better view of the vastus lateralis muscle. Take hold of the distal part of the ilio-tibial tract and pull it laterally, at the same time push the vastus lateralis medially, then the strong fibrous lateral intermuscular septum will be seen passing towards the linea aspera on the back of the femur.

Intermuscular Septa.—There are three intermuscular septa of the thigh: lateral, medial, and posterior (p. 235). The lateral is strong, the other two are both weak. Only the lateral and medial are to be examined at present.

The *lateral intermuscular septum* is a fibrous partition interposed between the vastus lateralis and intermedius anteriorly, and the popliteal fossa and the short head of the biceps femoris posteriorly. It springs from the deep surface of the ilio-tibial tract, and its deep border is attached to the lateral supracondylar ridge and to the lateral lip of the linea aspera of the femur. Parts of the vastus intermedius and vastus lateralis arise from its anterior surface, and some of the fibres of the short head of the biceps femoris spring from its posterior surface. Immediately proximal to the lateral condyle of the femur it is pierced by the *lateral superior genicular artery* and *nerve*. The *medial intermuscular septum*, which is thin in comparison with the lateral septum, should now be examined. It is interposed between the adductors and the vastus medialis. Its distal part, which is most distinct, passes laterally, from the fascia lata on the medial side of the thigh, behind the posterior border of the sartorius and behind the saphenous nerve, to the medial supracondylar ridge, and it lies in front of the distal part of the adductor magnus. Its proximal part is the thin layer of fascia on the anterior surfaces of the adductors magnus and longus, which is continuous above with the pectineal fascia.

M. Quadriceps Femoris.—The quadriceps femoris muscle is composed of four portions: the rectus femoris, which is placed in the anterior part of the thigh, and is quite distinct from the others, except at its insertion; the vastus lateralis, the vastus intermedius, and the vastus medialis, which clothe the body of the femur on its lateral, anterior, and medial aspects, and are more or less blended with each other.

M. Rectus Femoris.—The rectus femoris muscle arises by two tendinous heads of origin, which were exposed when the dissection was carried deeply in the interval between the iliacus and tensor of the fascia lata (p. 250). The *anterior* or *straight head* springs from the anterior inferior spine of the ilium (Fig. 116); the *posterior* or *reflected head* arises, under cover of the glutæus minimus, from a marked impression on the lateral surface of the ilium, immediately above the upper part of the rim of the acetabulum (Fig. 116). It is connected both with the capsule of the hip joint and the deep lamina of the ilio-tibial tract of the fascia lata.

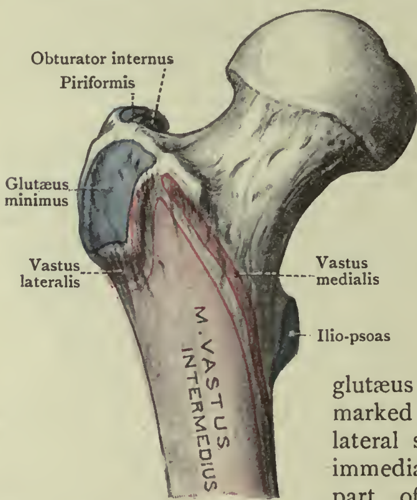


FIG. 117.—Anterior Aspect of Proximal Portion of Femur with Attachments of Muscles mapped out.

At the present stage of dissection only the anterior part of the reflected head is visible; the posterior part will be seen when the gluteal region is dissected.

The two heads of origin of the rectus femoris join at a right angle, immediately beyond the margin of the acetabulum, and form a strong, flattened tendon, which gives place to a fusiform, fleshy belly. The tendon of origin spreads out on the anterior surface of the proximal part of the muscle in the form of an aponeurosis. About three inches proximal to the knee joint the rectus femoris ends in a strong tendon of insertion, which is prolonged for some distance proximally, on its deep surface, in the form of an aponeurosis. As it nears the knee the tendon of the rectus femoris joins the other tendons of the quadriceps, and forms with them a common tendon which is inserted into the proximal border of the patella. The rectus femoris is supplied by the *femoral nerve.*

M. Vastus Lateralis.—The lateral vastus muscle forms the greater part of the prominent mass on the lateral side of the thigh. Its surface is covered by a glistening aponeurosis. The descending branch of the lateral circumflex artery constitutes the best guide to its anterior border, and when that margin is raised it will be seen that the muscle lies upon, and is partially blended with, the vastus intermedius.

The vastus lateralis arises—(1) from the upper part of the intertrochanteric line; (2) from the front of the trochanter major, distal to the insertion of the glutæus minimus; (3) from the inferior part of the trochanter major distal to the insertion of the glutæus medius; (4) from the lateral part of the gluteal tuberosity, anterior to the insertion of the glutæus maximus; (5) from the proximal part of the linea aspera; and (6) from the lateral intermuscular septum (Figs. 117, 118, 121). The fleshy fibres are for the most part directed distally and forwards. By means of the common tendon of insertion the muscle gains attachment to the patella and, at the same time, gives an expansion to the capsule of the knee joint. It is supplied by the *femoral nerve.*

Dissection.—Divide the rectus femoris about its middle, and pull the distal part forcibly towards the foot. The narrow interval between the tendons of the vastus intermedius and vastus medialis will then become apparent, and will serve as a guide to the line along which the muscles must be separated. Another guide to the line of separation is the long, slender nerve of supply to the articular muscle of the knee; it runs along the medial edge of the vastus intermedius. When the anterior border of the vastus medialis is raised from the vastus intermedius the medial surface of the body of the femur will be seen to be almost bare. Few muscular fibres arise from that bony surface. The fleshy mass of the vastus medialis may now, with advantage, be divided transversely about two inches proximal to the patella. The muscle can then be thrown medially, and its origin studied.

M. Vastus Medialis.—The vastus medialis is intimately connected with the vastus intermedius, but not to such an extent as might be inferred from a superficial inspection. In its proximal part the anterior border, which is fleshy, is either contiguous to or blended with the intermedius; distally, the

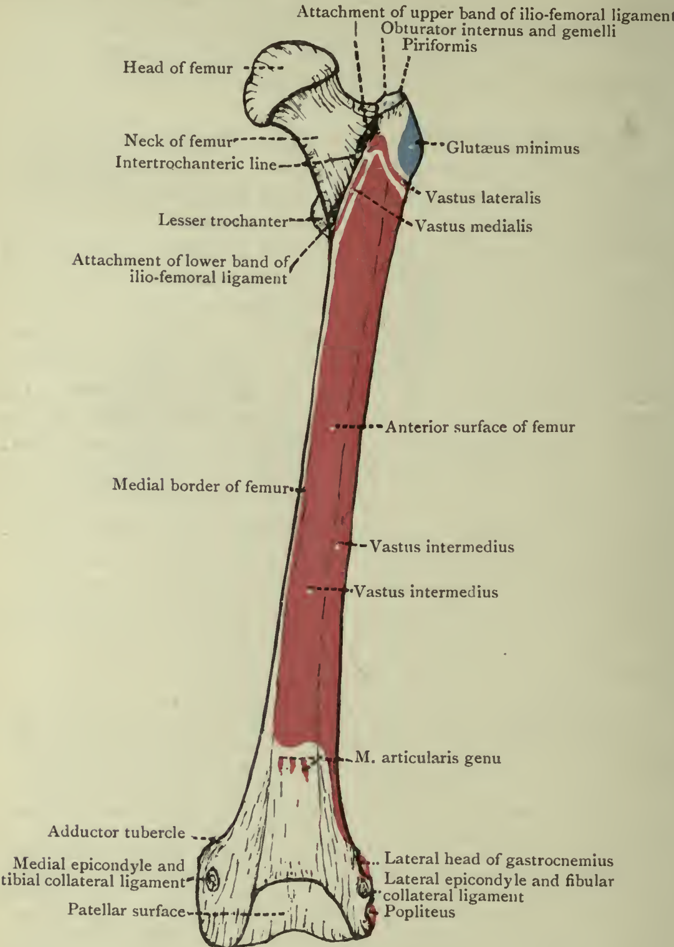


FIG. 118.—Diagram of the Femur seen from in front.

anterior border is tendinous and overlaps the intermedius, but it is not, as a rule, fused with it.

The vastus medialis arises—(1) from the lower part of the intertrochanteric line; (2) from the line extending from the intertrochanteric line to the linea aspera; (3) from the medial lip of the linea aspera; (4) from the proximal part of the medial supracondylar line as far distally as the opening in the adductor magnus (Figs. 118, 121); (5) from the rounded tendon of the adductor magnus. The fleshy fibres are directed distally and anteriorly, and end in the common tendon of the quadriceps muscle, which is inserted into the patella and becomes connected with the capsule of the knee joint. The muscle is supplied by the *femoral nerve.*

M. Vastus Intermedius (O.T. Crureus).—The vastus intermedius covers the anterior and lateral aspects of the body of the femur, from both of which, as well as from the distal part of the lateral intermuscular septum, it takes origin. It is inserted into the patella through the medium of the common tendon. It is supplied by the *femoral nerve.*

Common Tendon of the Quadriceps.—It should now be noticed that the common tendon of the quadriceps muscle closes the knee joint proximal to the patella. It is inserted into the proximal border of that bone, and is intimately connected with the capsule of the knee joint. Some fibres are carried distally, across the surface of the patella, into the ligamentum patellæ. A pouch of the synovial stratum is prolonged proximally beyond the level of the patella, between the quadriceps and the bone. Into the wall of that pouch the articular muscle of the knee is inserted.

Dissection.—The vastus intermedius should be divided in a vertical direction, so as to bring the little articular muscle into view, and at the same time the long, slender nerve-filament which runs along the medial border of the vastus intermedius may be traced to the muscle and the synovial stratum of the knee joint. The articular muscle consists of a few slips of muscle fibres which spring from the lower part of the front of the femur. They are inserted into the upper part of the synovial stratum of the capsule of the knee joint.

The *ligamentum patellæ*, which connects the patella with the tuberosity of the tibia, and through which the quadriceps is attached to that bone, will be studied in connection with the knee joint. It may be noted now that it is a broad, thick tendon, which extends from the patella to the tuberosity of the tibia.

The quadriceps femoris, acting as a whole, is an extensor of the knee, but the rectus femoris can also flex the hip joint.

The articularis genu merely lifts the upper part of the synovial stratum of the capsule of the knee to prevent its being caught between the bones as the knee joint is extended.

MEDIAL SIDE OF THE THIGH.

The group of adductor muscles on the medial aspect of the thigh, together with the blood-vessels and nerves associated with them, must next be dissected. As the dissection proceeds the following structures will be displayed :—

Muscles,	Pectineus. Adductor longus. Adductor brevis. Adductor magnus. Gracilis. Obturator externus.
Arteries,	Profunda femoris (and its branches). Obturator.
Nerves,	The two divisions of the obturator nerve. The accessory obturator nerve, when present.

The adductor muscles are disposed in three strata. The *anterior stratum* is formed by the pectineus and the adductor longus, which lie in the same plane. Their adjacent borders touch one another proximally, but distally they are separated by a small interval. The *second stratum* is formed by the adductor brevis; and the *third*, or *posterior layer*, by the adductor magnus. The gracilis muscle, also an adductor, extends along the medial aspect of the thigh. It is a long, strap-like muscle, applied against the adductor brevis and adductor magnus. Interposed between the three muscular layers are the two divisions of the *obturator nerve.* The *anterior division* is placed between the anterior and middle layers; the *posterior division* lies between the middle and posterior layers. In other words, the adductor brevis intervenes between them. At the distal border of the adductor longus, a fine branch from the anterior division of the nerve makes its appearance; it takes part in the formation of the sub-sartorial nerve plexus already dissected. The profunda artery and its branches also are to be followed. For a part of its course this vessel is placed between the anterior and middle muscular strata.

M. Adductor Longus.—The adductor longus muscle is placed on the medial side of the pectineus. It is somewhat triangular in shape, being narrow at its origin and expanded at its insertion. It arises by a short, but strong, tendon from the anterior surface of the body of the pubis, immediately below the pubic crest (Fig. 116), and it is inserted into the medial lip of the linea aspera of the femur by a thin, tendinous expansion. It is supplied by the *anterior division* of the *obturator nerve.* It acts like the adductor brevis (p. 272).

Dissection.—Divide the adductor longus 25 mm. below its origin. Turn the proximal part upwards and notice how the flat tendon is so curved upon itself that it simulates the appearance of a round tendon. Turn the distal portion towards the femur, and secure its nerve of supply from the anterior division of the obturator nerve, which lies posterior to the muscle. As the femur is approached the muscle fibres will be found to terminate in a thin aponeurosis, by which the muscle is attached to the linea aspera. This aponeurosis of insertion is intimately connected anteriorly with the vastus medialis and posteriorly with the adductor magnus. Separate it from both as far as possible; especially from the adductor magnus, in order to display the profunda vessels, which lie, in part of their course, between the adductors longus and magnus.

Art. Profunda Femoris.—This large vessel is the chief artery of supply to the muscles of the thigh. It arises, in the femoral triangle, from the lateral and posterior aspect of the femoral artery, about an inch and a half distal to the inguinal ligament. At first it is placed on the iliacus, but, as it proceeds distally, it inclines medially, and thus it crosses posterior to the femoral artery, and comes to lie on the pectineus. Reaching the upper border of the adductor longus, it passes posterior to that muscle, and is continued distally, close to the body of the femur, in front of the adductor brevis and adductor magnus. Numerous large branches spring from the profunda femoris, so that it rapidly diminishes in size. Ultimately it is reduced to a fine terminal twig, which turns backwards through the adductor magnus, and receives the name of the *fourth perforating artery.* The following are the relations of the profunda femoris:—(1) It lies anterior to the iliacus, on the lateral side of the femoral artery. (2) It is anterior to the pectineus and posterior to the femoral artery, but separated from it by the femoral vein and the profunda femoris vein. (3) It is anterior to the adductor brevis, and, more distally, to the adductor magnus, and it is posterior to the adductor longus, which separates it from the femoral vessels.

(4) The terminal twig, called the fourth perforating artery, pierces the adductor magnus in the middle third of the thigh.

The *branches* which spring from the profunda femoris are :—the two femoral circumflex arteries, the four perforating arteries, and some muscular branches.

The *lateral femoral circumflex artery* arises from the lateral aspect of the profunda, close to its origin. It has already been followed to its distribution (p. 260). The *medial*

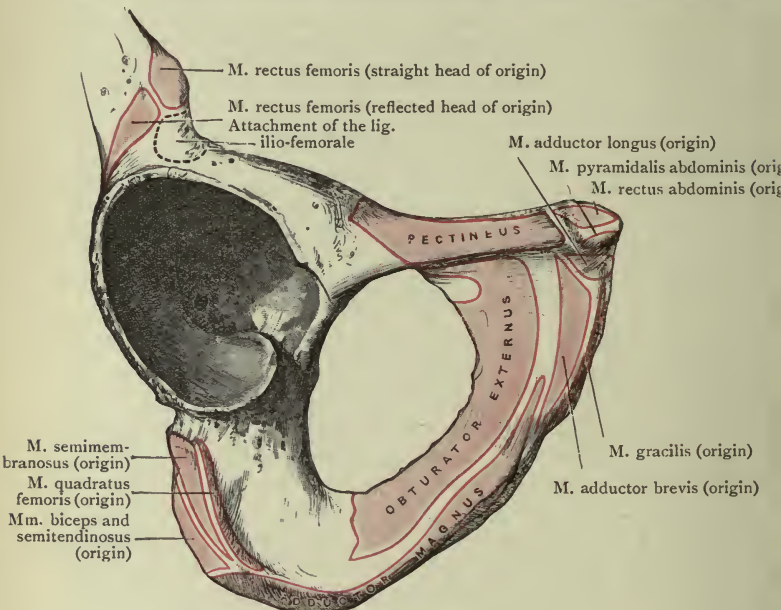


FIG. 119.—External Surface of the Os Pubis and Ischium, with Attachments of Muscles mapped out.

femoral circumflex artery which takes origin at the same level, but from the medial and posterior aspect of the profunda, will be studied when the pectineus muscle is reflected. The medial femoral circumflex artery frequently arises from the femoral trunk. The *muscular branches* are irregular both in origin and size. They supply the adductor muscles, and give twigs which pierce the adductor magnus to reach the hamstring muscles.

Arteriæ Perforantes.—The perforating arteries arise in series from the profunda femoris, and pass backwards through the adductor muscles to the posterior region of the thigh. They may be recognised from the close relation which they bear to the linea aspera of the femur. The *first perforating artery* comes off at the level of the distal or medial border of the pectineus. It proceeds backwards through the adductor brevis and adductor magnus. The *second perforating artery* takes origin a short distance distal to the first perforating, or perhaps by a common trunk with it. It pierces the same muscles, viz., the adductor brevis and adductor magnus. The *third perforating artery* springs from the profunda, distal to the adductor brevis, and passes backwards through the adductor magnus. The *fourth perforating artery*, as before noted, is the terminal branch of the profunda femoris; it pierces the adductor magnus alone.

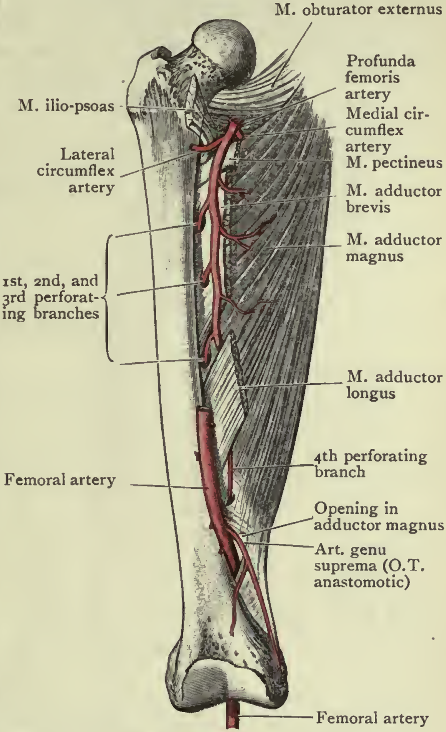


FIG. 120.—The Profunda Femoris Artery and its Branches.

The *superior nutrient artery* of the femur may spring from either the second or the third perforating branch. An *inferior nutrient artery* is frequently present; it is often derived from the fourth perforating artery.

When the adductor magnus is more fully exposed it will be seen that the perforating arteries, as they pierce its tendon, are protected by a series of fibrous arches. The further course of the perforating arteries is dealt with on p. 323.

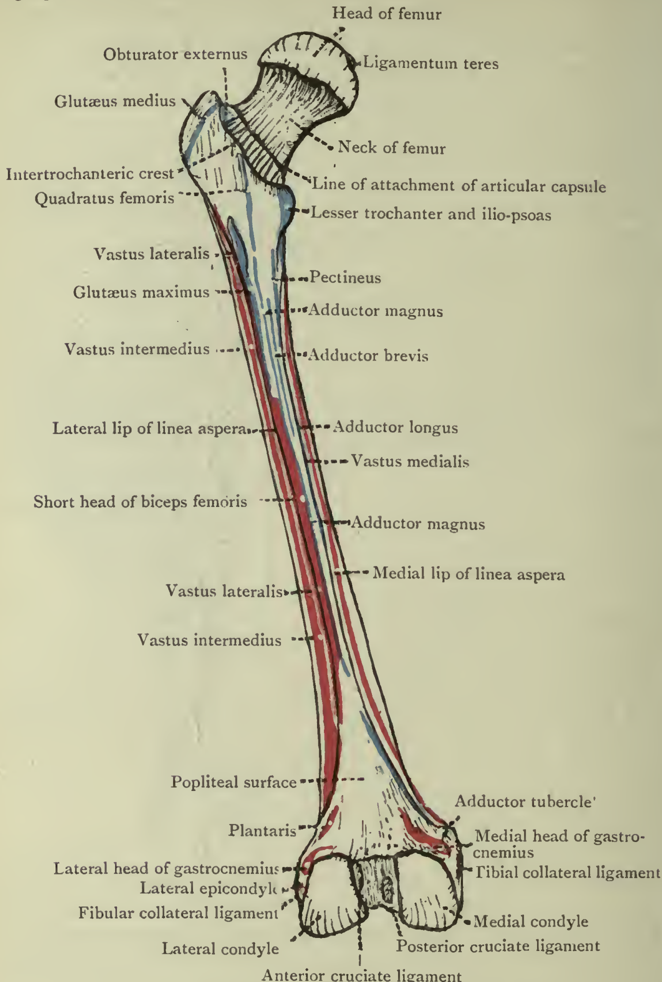


FIG. 121.—Diagram of the Femur seen from behind.

M. Pectineus.—The pectineus muscle is placed between the adductor longus and the ilio-psoas. It is flat and somewhat broader at its origin from the brim of the pelvis than at its insertion into the femur. It has a fleshy origin, from the pectineal line of the pubis, and from the surface of the hip bone anterior to it (Fig. 116). Some fibres are derived also from the lacunar ligament. It descends obliquely, laterally and backwards, and gains insertion into the back of the femur, lateral to the lesser trochanter, and to a certain extent also into the line which leads from that prominence towards the linea aspera (Figs. 121, 122). It is supplied by the *femoral nerve.* The pectineus adducts the femur and rotates the thigh laterally. It also assists in flexion of the hip joint.

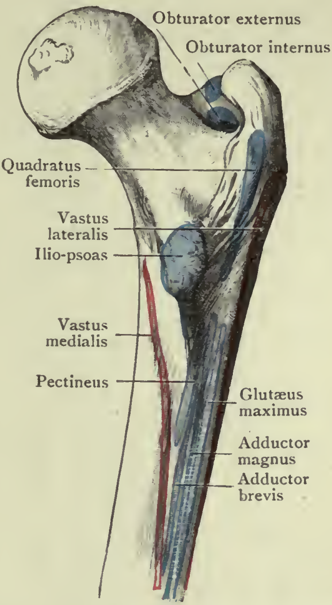


FIG. 122.—Posterior Aspect of Proximal Portion of Femur, with the Attachments of Muscles mapped out.

Dissection. **— Detach the pectineus from its origin, and throw it towards its insertion. Whilst separating the muscle from the pubis the dissector must bear in mind that in some cases an *accessory obturator nerve* descends into the thigh, under cover of its lateral margin, and over the pubis. Care must also be taken not to injure (1) the anterior division of the obturator nerve which lies posterior to the muscle, or (2) the medial femoral circumflex artery which passes posteriorly in contact with the lateral border of the muscle (Fig. 113).**

Nervus Obturatorius Accessorius.—The accessory obturator nerve, when present, arises within the abdomen either from the lumbar plexus or from the obturator trunk near its origin (Fig. 124). In the thigh it gives a branch to the hip joint and joins the anterior division of the obturator nerve. It is very rare to find a twig given to the pectineus either by it or by the trunk of the obturator nerve itself.

Art. Circumflexa Femoris Medialis.—The medial femoral circumflex artery springs from the medial and posterior aspect of the profunda femoris artery, at the same level as the lateral femoral circumflex branch. It passes posteriorly between the adjacent margins of the psoas and the pectineus, and then between the adductor brevis and the obturator externus, to the posterior region of the thigh, where, close to the lesser trochanter, it divides into an ascending and a transverse terminal branch. Before the main trunk divides it gives off (1) a superficial branch which passes, medially, across the front of the pectineus and then between the adductors longus and brevis, and (2) an articular branch which enters the hip joint through the acetabular notch. The terminal branches will be examined in the dissection of the gluteal region.

Branches of the Femoral Artery.—In every region of the thigh the dissector has met with branches of the femoral artery. It is well now that he should revert to this vessel and study its branches in the order in which they arise. The following Table may aid him in doing this:—

A. femoralis.	Aa. pudendæ externæ.		Superficial inguinal.
	A. epigastrica superficialis.		
	A. circumflexa ilium superficialis.		
	A. profunda.	A. circumflexa femoris lateralis.	
		A. circumflexa femoris medialis.	
		A. perforans prima.	Aa. Nutritiæ.
		A. perforans secunda.	
		A. perforans tertia.	
		A. perforans quarta (terminal).	
	Rami Musculares.		
	A. genu suprema.		

M. Adductor Brevis.—The short adductor muscle lies posterior to the adductor longus and the pectineus. It arises, below the origin of the adductor longus, from the anterior aspect of the body and the inferior ramus of the os pubis (Fig. 116). As it descends it inclines posteriorly and laterally; and it is inserted, posterior to the pectineus, into the greater part of the line which extends from the lesser trochanter to the linea aspera (Fig. 121), and into the proximal part of the linea aspera, lateral to the adductor longus. It is supplied by the *obturator nerve.* It is an adductor and a lateral rotator of the thigh and a flexor of the hip joint.

Dissection.—Divide the adductor brevis, parallel with and close to its origin, and turn it towards its insertion, but do not injure the anterior division of the obturator nerve which lies in front of it. When the muscle is reflected the posterior division of the obturator nerve will be exposed. Trace the nerve, proximally, to the point where it pierces the obturator

externus at the obturator foramen, and, distally, to its disappearance in the adductor magnus.

Nervus Obturatorius.—The obturator nerve is a branch of the lumbar plexus. It escapes from the pelvis by passing,

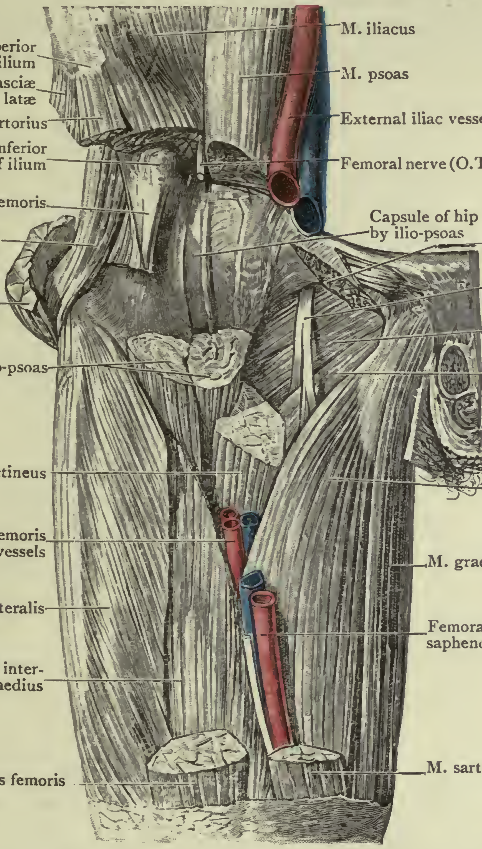
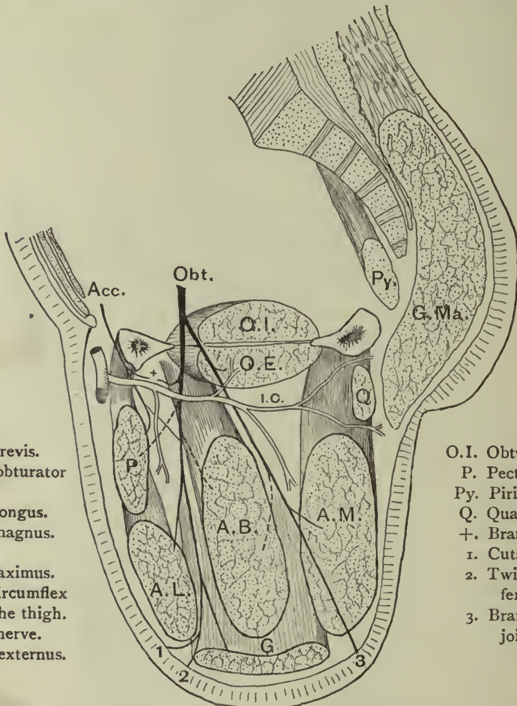


FIG. 123.—Dissection of the Front of the Thigh. The hip joint has been exposed by removing portions of the muscles which lie anterior to it.

with its companion vessels, through the upper part of the obturator foramen of the hip bone (Fig. 125). While still within the foramen it divides into an anterior and a posterior division.

The *anterior division* of the obturator nerve enters the thigh over the upper border of the obturator externus muscle, and proceeds, distally, upon the anterior surface of the adductor brevis. Anterior to it are the pectineus and adductor longus muscles. It gives branches to three muscles, viz., the adductor longus, the adductor brevis, and the gracilis. Very rarely



A.B. Adductor brevis.
Acc. Accessory obturator nerve.
A.L. Adductor longus.
A.M. Adductor magnus.
G. Gracilis.
G.Ma. Glutæus maximus.
I.C. Medial circumflex artery of the thigh.
Obt. Obturator nerve.
O.E. Obturator externus.

O.I. Obturator internu
P. Pectineus.
Py. Piriformis muscle.
Q. Quadratus femoris
+. Branch to hip joir
1. Cutaneous branch
2. Twig to walls femoral artery.
3. Branch to kn joint.

FIG. 124.—Diagram to illustrate the distribution of the Obturator Nerve and the general disposition of the Adductor Muscles of the Thigh (Paterson).

it supplies a twig to the pectineus. In addition to these branches it also supplies—(1) an *articular branch* to the hip joint (Fig. 124. +); (2) a fine twig, which appears at the distal border of the adductor longus, to join the sub-sartorial plexus; and (3) a *terminal twig*, which goes to the femoral artery—(Fig. 124)—and breaks up into fine filaments upon its walls.

The *posterior branch* of the obturator nerve, as it enters the thigh, pierces the upper border of the obturator externus. It extends distally, between the adductor brevis and the adductor magnus, and is expended chiefly in the supply of the latter muscle. It gives also, however, a branch to the obturator externus and an *articular branch* to the knee joint. The latter branch pierces the distal part of the

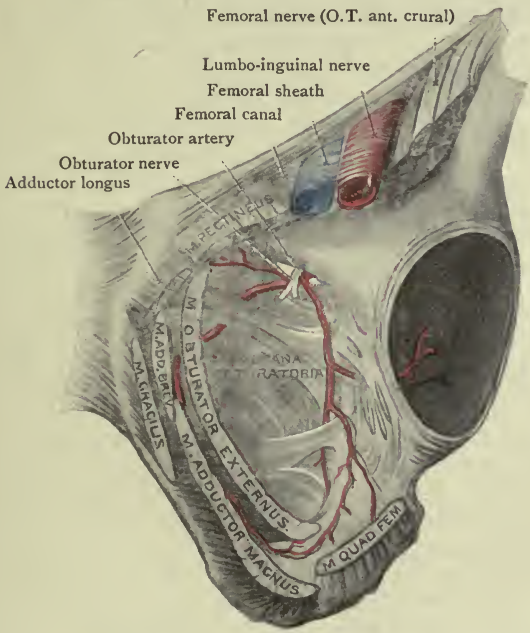


FIG. 125.—Dissection to show the Structures surrounding the Obturator Foramen of the Hip Bone.

adductor magnus, close to the linea aspera, and may be seen in the popliteal fossa, lying posterior to the popliteal artery.

M. Gracilis.—The gracilis is a long, strap-like muscle, which lies along the medial aspect of the thigh and knee. It springs, by a thin tendon, from the lower half of the body of the pubis, close to the symphysis, and also from the upper half of the pubic arch (Fig. 119). It ends in a slender, rounded tendon which inclines forwards, distal to the knee, and then expands and is inserted into the proximal part of the medial surface of the tibia, under cover of the tendon of the sartorius, and at a higher level than the insertion of the semitendinosus (Fig. 139, p. 322). A mucous bursa separates the expanded tendon of the gracilis from the tibial collateral ligament of the knee joint, and is prolonged proximally, so as to intervene between it and the tendon of the sartorius. The gracilis is supplied by the *anterior division* of the *obturator nerve.* It adducts the thigh, flexes the knee joint and rotates the leg medially.

M. Adductor Magnus.—The adductor magnus is one of the most powerful muscles of the thigh. It forms a flat, fleshy mass, which springs from the anterior surface of the entire length of the pubic arch of the corresponding side, and from the lower part of the ischial tuberosity (Figs. 128, 129). The fibres which arise from the pubic arch spread out as they approach the posterior aspect of the femur; the more medial in origin are the more horizontal in direction; the more lateral in origin are the more oblique in direction. They are inserted into the posterior part of the femur, just medial to the gluteal tuberosity, into the linea aspera, and into a small portion of the proximal part of the medial supracondylar ridge (Figs. 121, 122). The fibres which take origin from the ischial tuberosity descend almost vertically and form the thick medial border of the muscle. In the distal third of the thigh they end in a strong, rounded tendon, which is inserted into the adductor tubercle on the medial condyle of the femur (Figs. 120, 121). This tendon is further attached to the femur by the medial intermuscular septum which stretches between it and the medial supracondylar line. Close to the linea aspera are the fibrous arches, formed in connection with the insertion of the adductor magnus, for the passage of the perforating arteries, and in series with them is the opening through which the femoral artery enters the popliteal fossa. The opening is a gap between two portions of the muscle, and is situated at the junction of the proximal two-thirds with the distal third of the thigh (Fig. 120).

The adductor magnus has a double nerve supply. The fibres which spring from the pubic arch are supplied by the posterior branch of the *obturator nerve.* Those which arise from the ischial tuberosity are supplied by the *sciatic nerve.*

The fibres which spring from the rami of the pubis and ischium act like the fibres of the other adductor muscles, that is, they adduct the thigh, rotate it laterally, and help to flex the hip joint, but the fibres which arise from the tuberosity of the ischium and are inserted, by tendon, into the adductor tubercle of the femur extend the hip joint.

Dissection.—Detach the adductor magnus from its origin from the pubic and ischial rami, in order that the obturator externus muscle and the obturator artery may be more fully examined.

M. Obturator Externus. — The obturator externus is a flat, fan-shaped muscle, which is placed over the anterior aspect of the obturator foramen of the hip bone. It springs from the medial half of the membrane which closes the foramen, and also from the medial and lower part of its bony margin (Figs. 119, 128). It passes backwards and laterally, below and behind the neck of the femur and the capsule of the hip joint, and ends in a stout tendon which obtains insertion into the trochanteric fossa (Figs. 121, 122). This tendon will be examined in the dissection of the gluteal region. The obturator externus is supplied by the *posterior division* of the *obturator nerve.* It is a flexor of the hip joint and an adductor and lateral rotator of the thigh.

Art. Obturatoria.—The obturator artery appears in the thigh through the upper part of the obturator foramen of the hip bone. It at once divides into two terminal branches, which diverge from each other and form an arterial circle upon the obturator membrane, under cover of the obturator externus. The muscle must therefore be detached in order that the vessels may be followed. Both branches give twigs to the neighbouring muscles, whilst the *posterior branch* sends an *articular twig* through the acetabular notch into the hip joint. When the joint is opened this twig may be followed, in a well-injected subject, along the ligamentum teres into the head of the femur.

Mm. Psoas Major and Iliacus.—Both the psoas major and the iliacus muscles arise within the abdomen, and they enter the thigh posterior to the inguinal ligament. A tendon appears on the lateral side of the psoas major, and into this the fibres of the iliacus are for the most part inserted. The conjoined tendon of the ilio-psoas is implanted into the lesser trochanter of the femur, but a certain proportion of the fleshy fibres of the iliacus obtain direct insertion into the body of the femur, distal to that prominence (Figs. 121, 122).

The action of the psoas major and the iliacus depend upon the position of the hip joint when the muscles are in action. If the hip joint is extended they flex it, and rotate it medially until it is flexed; then they rotate it laterally.

Dissection.—Divide the femoral vessels and the femoral nerve, about an inch distal to the inguinal ligament, and having tied them together with twine throw them distally. Now cut through the sartorius and the rectus femoris, about two inches from their origins, and turn them aside. The tendon of the ilio-psoas must next be detached from its insertion and, with the muscle, turned upwards. This will expose the anterior surface of the capsule of the hip joint. An intervening mucous bursa also will be displayed. Open this and ascertain its extent by introducing the finger. It facilitates the play of the ilio-psoas upon the front of the hip joint, and in some cases its cavity will be found to be directly continuous with the cavity of the joint, through an aperture in the capsule. The intimate connection which exists between the capsule of the hip joint and the tendon of the glutæus minimus, the reflected head of the rectus femoris, and the deep layer of the ilio-tibial tract, should be noticed. Lastly, turn aside the tensor fasciæ latæ, and carefully clean the anterior aspect of the capsule of the hip joint.

At the end of the fifth day the dissector must paint the various parts of the anterior and medial regions of the thigh with preservative solution, replace them in position and fix the skin flaps over them with a few points of suture.

On the morning of the sixth day, after the dissection of the lower limb has been begun, the subject is placed upon the table with its face downwards and its thorax and pelvis supported by blocks. In that position it is allowed to remain for *five* days, and during that time the dissector of the lower extremity has a very extensive dissection to perform. He has to dissect—(1) the gluteal region; (2) the popliteal fossa; and (3) the posterior region of the thigh. With so much work before him, and being limited as to the time in which it must be done, it is necessary that he should apportion the five days at his disposal so as to complete the dissection before the body is turned again. The *first two days* he should devote to the study of the gluteal region; the *third* and *fourth days* may be given to the popliteal fossa; and on the *fifth day* he should undertake the dissection of the back of the thigh, and revise the work of the preceding four days.

GLUTEAL REGION.

In the gluteal region the following parts will be displayed in the course of the dissection:—

1. Superficial fascia.
2. Cutaneous nerves and blood-vessels.
3. Deep fascia.
4. Glutæus maximus (and after this has been reflected),
   Three mucous bursæ.
   The glutæus medius and minimus.
   The two gemelli muscles and the tendon of the obturator internus.
   Tendon of the obturator externus.
   Proximal border of the adductor magnus.
   The origin of the hamstrings from the ischial tuberosity.
   The proximal part of the vastus lateralis.
5. The sacro-tuberous ligament. (O.T. great sciatic lig.)
6. Arteries . . Superior gluteal.
   Inferior gluteal (O.T. sciatic).
   Internal pudendal.
   Medial femoral circumflex.
7. Nerves . . Superior gluteal.
   Sciatic.
   Posterior cutaneous of the thigh.
   Pudendal.
   Nerve to obturator internus.
   Nerve to quadratus femoris.
   Inferior gluteal.

Supposing that *two days* are allowed for the above dissection, the **first day's work** should consist of—(1) the dissection of the parts superficial to the glutæus maximus; (2) the cleaning and reflecting of that muscle; (3) the tracing and defining of the various nerves and blood-vessels which enter its deep surface. **On the second day** the parts which are exposed by the reflection of the glutæus maximus should be dissected.

Surface Anatomy.—Before the skin is reflected the surface markings of the gluteal region must be examined. On each side the prominence of the nates forms a round, smooth elevation. Inferiorly the nates are separated, in the middle line, by a deep fissure—the *natal cleft.* The cleft can be traced upwards over the coccyx to the level of the lower part of the sacrum where it disappears. The crest of the ilium can be felt along its whole length, and in the well-formed male its position is indicated by a groove—the *iliac furrow.* The anterior end of the crest terminates in the anterior superior spine of the ilium; the posterior end is the posterior superior spine of the ilium. The position of the latter is indicated by a faint depression or dimple which lies on a level with the second spine of the sacrum, and it corresponds with the middle of the sacro-iliac articulation. The prominence of the nates is formed chiefly by the glutæus maximus muscle, covered by a thick layer of fat. A deep transverse groove, produced by a fold of skin and fascia, limits the gluteal elevation below. The groove is called the *gluteal sulcus*, and is sometimes said to correspond with the distal border of the glutæus maximus muscle. It can easily be shown that this is not the case. Its medial end lies distal to the inferior margin of the muscle, but as the sulcus proceeds transversely it crosses the border of the muscle, and finally comes to lie on the surface of the muscle. In disease of the hip joint, the buttock loses its prominence, whilst the gluteal sulcus becomes faint. The tuberosity of the ischium may be felt, deep to the lower border of the glutæus maximus, if the fingers are placed in the medial part of the gluteal sulcus and pressed upwards. A line drawn from the most prominent part of this tuberosity to the anterior superior spine of the ilium is called *Nelaton's line*; it passes over the top of the greater trochanter and crosses the centre of the acetabulum; and it is used by the surgeon in the diagnosis of dislocations and other injuries of the hip joint. The greater trochanter of the femur may be felt at a point about six inches below the highest part of the crest of the ilium. It can be seen in thin subjects, but it does not form so projecting a feature of this region as might be expected from an inspection of the skeleton, because the thick tendon of the glutæus medius is inserted into its lateral surface, and it is covered also by the aponeurotic insertion of the glutæus maximus.

Dissection.—Reflection of Skin.—*Incisions.*—(1) From the posterior superior spine of the ilium in a curved direction along the crest of the ilium, as far forwards as the position of the body will permit; (2) from the posterior extremity of this curved incision obliquely downwards and medially to the middle line of the sacral region, and then perpendicularly to the tip of the coccyx; (3) from the tip of the coccyx obliquely distally and laterally over the back of the thigh, to the junction of the proximal and distal halves of the posterior border of the lateral area of the thigh.

A large flap of skin is thus marked out, and this must be raised from the subjacent superficial fascia and thrown laterally. On the right side of the body the dissector begins at the crest of the ilium and works downwards and forwards; whilst on the left side he commences over the coccyx and works upwards and forwards.

Superficial Fascia (Panniculus Adiposus).—After the skin

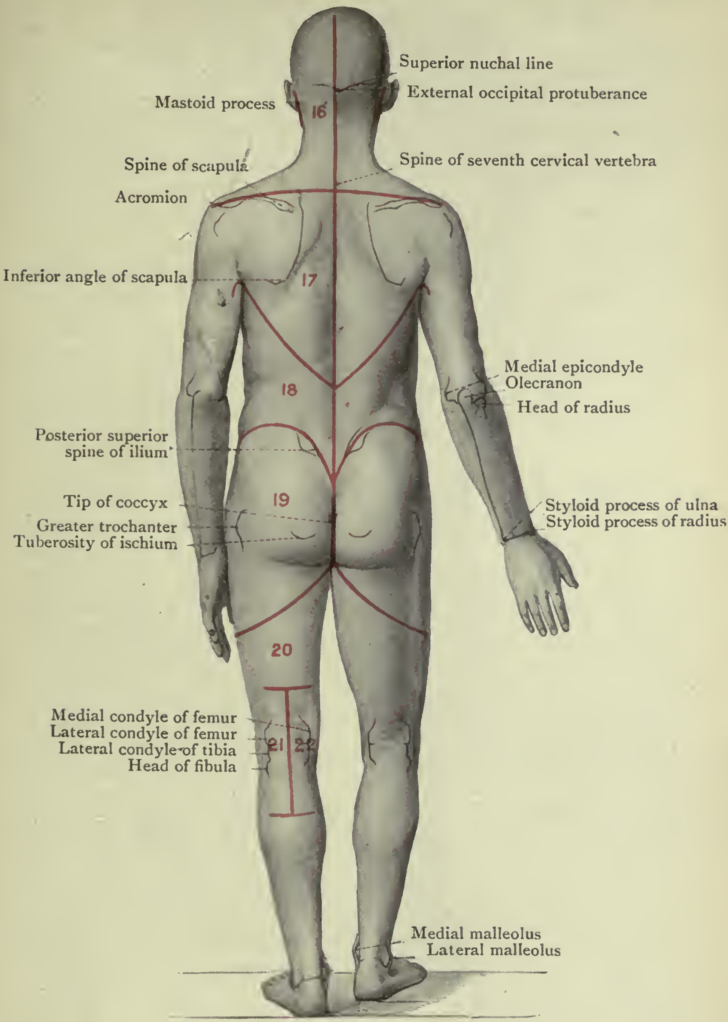


FIG. 126.—Surface view, showing incisions and bony points.

is reflected the superficial fascia which is exposed, is seen to partake of the same characters as the corresponding layer of fascia in other parts of the body. It presents, however, certain special peculiarities. It is much more heavily laden with fat—more particularly so in the female; it thickens over the upper and lower margins of the glutæus maximus, and it becomes tough and stringy over the ischial tuberosity, where it forms a most efficient cushion upon which this bony prominence rests while the body is in the sitting posture.

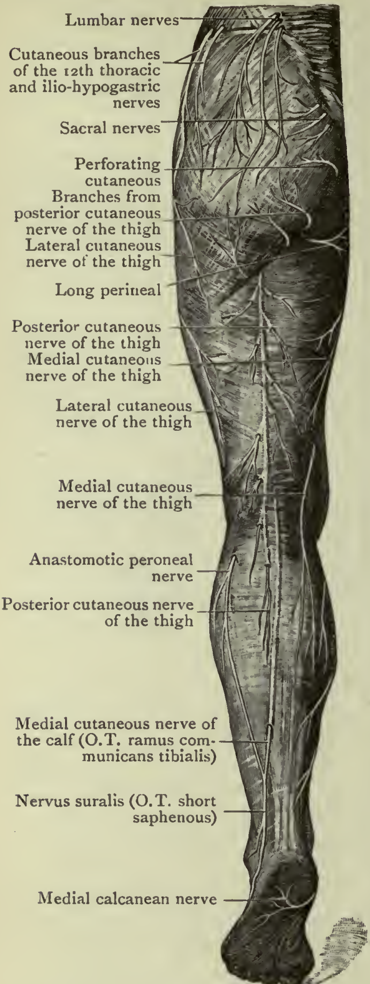


FIG. 127.—Cutaneous Nerves on the posterior aspect of the Inferior Extremity.

Nervi Cutanei (Fig. 127).—The cutaneous nerves of the gluteal region are numerous. Some of them are difficult to find and, if the subject is obese, many of them are so embedded in the fat, at different levels, that a satisfactory display of the whole series is not easily obtained. Therefore the dissector, working upon the buttock for the first time, mnst not be disappointed if the final result of his work does not quite realise his hopes and expectations.

The nerve twigs distributed to the skin of the gluteal region are derived from the anterior ramus of the last thoracic and from the anterior and posterior rami of the lumbar and sacral nerves, and they ramify, as in other regions, in the superficial fascia on their way towards their terminations.

The nerves which must be sought for are—

Branches of anterior rami of spinal nerves.	Lateral branch of last thoracic. Lateral branch of the ilio-hypogastric. Twigs from the posterior branch of the lateral cutaneous nerve of the thigh. Twigs from the posterior cutaneous nerve of the thigh. The perforating cutaneous nerve.
Branches of posterior rami of spinal nerves.	Branches from the three upper lumbar nerves. Three branches from the sacral nerves.

The branches of the sacral nerves supply the skin of the lower and medial area of the buttock. The lumbar nerves are distributed to the upper part of the medial area and to the upper two-thirds of the intermediate area. The lateral branches of the ilio-hypogastric, the last thoracic nerve, and the lateral cutaneous nerve of the thigh supply the lateral area, and the lower area along the fold of the buttock receives the perforating cutaneous nerve and twigs from the posterior cutaneous nerve of the thigh (Fig. 127).

Dissection.—Seek first for the branches of the posterior rami of the sacral nerves. Make an incision through the superficial fascia along a line, commencing 2 cm. medial to the posterior superior spine of the ilium and terminating at the tip of the coccyx. Then reflect the lateral part of the superficial fascia away from the median plane and secure the nerves as they pierce the deep fascia superficial to the sacral and coccygeal origins of the glutæus maximus muscle. They are usually three in number; all are small, but the middle of the three is usually the largest of the series, and as a rule they are situated about 25 mm. from one another.

The branches of the posterior rami of the lumbar nerves should next be sought. Make an incision *into* but *not through* the superficial fascia along the line of the crest of the ilium. The object of the incision is to enable the dissector to raise a superficial layer of the superficial fascia, and its depth must vary with the obesity of the subject. In a very fat subject it may be 3 or 4 mm. deep, but in a thin subject it must not be more than 2 mm. deep. After the incision is made, raise a superficial layer of the lower part of the superficial fascia, throw it towards the trochanter major, and secure twigs of the lumbar nerves as they pass from the deeper to the more superficial layers of the fascia. As soon as a twig is found, follow it towards the iliac crest; it will lead to the trunk from which the twig issues. As soon as the trunk is secured, trace it and its branches towards their terminations. As the branches are being cleaned twigs from the adjacent lumbar nerves are certain to be exposed, for the twigs from adjacent nerves cross one another and sometimes unite with one another. Trace such twigs to their sources of origin ; when the trunk from which they arise is found, follow it and its branches to their peripheral distribution. If the plan outlined is followed the dissector will demonstrate the branches of the lumbar nerves without any great difficulty. He should then attempt to find the lateral branches of the ilio-hypogastric and last thoracic nerves, following the same plan of search. The trunks of the two branches cross the iliac crest anterior to the lumbar nerves, the lateral branch of the last thoracic about 5 cm. posterior to the anterior superior spine of the ilium and the lateral branch of the ilio-hypogastric a centimetre or more further back. If the branches of the posterior division of the lateral cutaneous nerve of the thigh were found and left in position when the anterior part of the thigh was dissected, they may be revised now, otherwise the dissector need waste no time in looking for them, for they will have been already removed. No time need be lost in looking for the perforating cutaneous nerve. It pierces the deep fascia and enters the superficial fascia near the medial part of the lower border of the glutæus maximus about 2 or 3 cm. from the tip of the coccyx and medial to the ischial tuberosity, and it has either been displayed and left *in situ* by the dissector of the perineum, or it has been removed. To display the gluteal branches of the posterior cutaneous nerve of the thigh, cut through the superficial fascia along the lower border of the glutæus maximus till the deep fascia is exposed, then reflect the superficial fascia upwards and secure the branches sought for as they pierce the deep fascia about midway between the trochanter major and the tuber ischii.

In well-injected subjects many of the nerves mentioned are accompanied by small injected arteries which serve as guides to the nerves, but such arteries cannot be depended upon, and the dissector should rely upon his senses of sight and touch to enable him to distinguish the firmer nerve fibres from the strands of connective tissue which permeate the fat.

After the cutaneous nerves have been demonstrated the remains of the superficial must be removed both from the region of the glutæus maximus and the region anterior to it in order that the deep fascia may be examined.

Deep Fascia.—The deep fascia now exposed differs in character in the anterior and posterior parts of its extent. In front of the glutæus maximus, where the fascia lies over the anterior part of the glutæus medius, it is dense in texture and opaque and pearly white in colour. That part stands in marked contrast with the deep fascia over the glutæus maximus itself, which is thin and transparent. Subsequent dissection will show that the dense fascia over the anterior part of the glutæus medius, when it reaches the anterior border of the glutæus maximus, splits into two lamellæ which enclose the glutæus maximus between them.

Dissection.—Follow the branches of the posterior cutaneous nerve of the thigh to the trunk of that nerve at the lower border of the glutæus maximus, and after the trunk of the nerve is secured, proceed to clean the glutæus maximus. The dissector of the right inferior extremity should begin at the upper border of the muscle and work downwards, the dissector of the left limb should work upwards from the inferior border. On the right side the dissector should cut through the deep fascia a little below the upper border of the muscle, then he should raise the upper portion of the divided fascia until the upper border of the muscle is exposed, and the fascia superficial to it is found to blend with the strong fascia covering the glutæus medius. The upper border of the muscle should now be raised and drawn downwards to display the layer of deep fascia subjacent to it. When this has been done the dissector will readily realise that the strong fascia on the more anterior part of the glutæus medius splits at the upper border of the maximus into a superficial layer which covers the maximus and a deep layer which passes downwards over the lower part of the glutæus medius and the muscles which lie more distally at the back of the hip joint. The dissector on the left side will demonstrate the same facts when he reaches the upper border of the muscle, for he will find the deep fascia which he has raised from the surface of the glutæus maximus blends with the strong fascia on the glutæus medius,and by lifting the upper border of the maximus he will display the deeper layer of fascia.

The glutæus maximus is a difficult muscle to clean, as the fasciculi are exceedingly coarse. It is necessary therefore not only to remove the fascia which covers the muscle, but at the same time to follow, for a short distance, the septa which penetrate between the fasciculi and to remove them also. Do not remove the thick opaque fascia which covers the insertion of the muscle.

If the work is to be done well the dissector must keep clearly before him the rules which have already been laid down regarding the cleaning of a muscle : (1) Render the fibres as tense as possible by rotating the limb medially ; (2) remove the fascia in one continuous layer ; (3) always cut in the direction of the muscular fibres ; (4) define very carefully the borders of the muscle.

M. Glutæus Maximus.—The glutæus maximus is a powerful muscle which arises—(1) from a narrow, rough area on the dorsum ilii, which is included between the posterior curved line and the outer lip of the crest ; (2) from the sides of the lower two pieces of the sacrum and the upper three pieces of the coccyx ; (3) from the entire posterior surface of the sacro-tuberous ligament (O.T. great sciatic); and (4), slightly, from the posterior layer of the lumbo-dorsal fascia, at the attachment of that fascia to the crest of the ilium.

From this extensive origin the coarse fasciculi of the muscle proceed obliquely downwards and forwards towards the proximal portion of the femur ; but only a comparatively small proportion of them receive direct insertion into that bone. The greater part of the muscle is inserted into the fascia lata. To be more precise, it may be said that the deeper fibres of the lower half of the muscle are directly attached

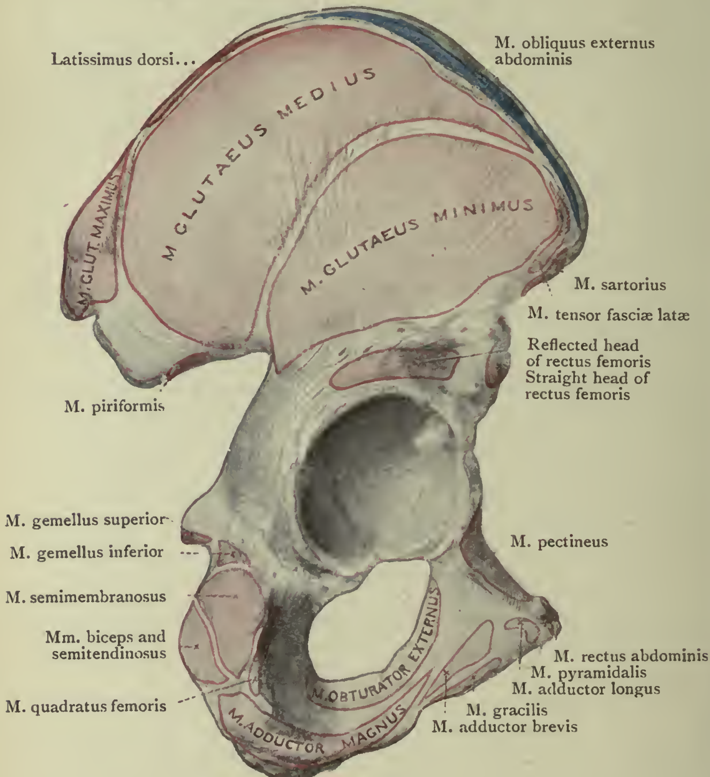


FIG. 128.—External aspect of the Hip Bone, with the Attachments of the Muscles mapped out.

to the gluteal tuberosity on the back of the femur (*i.e.* the ridge which extends from the greater trochanter to the linea aspera). (Fig. 122, p. 271.) All the remaining fibres of the muscle are inserted into the fascia lata along the posterior border of the proximal part of the ilio-tibial tract. The glutæus maximus is supplied by the *inferior gluteal nerve.* The glutæus maximus is an extensor of the hip joint and a lateral rotator of the thigh. Its upper fibres can abduct the thigh, acting with the tensor fasciæ, and the lower fibres assist in producing adduction.

Dissection.—**Reflection of the Glutæus Maximus.**—As the glutæus maximus is reflected the dissector must be careful not to injure the vessels and nerves which lie closely subjacent to it. The nerves most liable to injury are the posterior cutaneous nerve of the thigh, which has already been identified and secured if previous instructions have been followed (see p. 284), and the perforating cutaneous nerve, which is very liable to injury when the fibres of the glutæus maximus are being raised from the sacro-tuberous ligament.

The incision through the muscle should extend from a point on its superior border 3 cm. above the trochanter major to a point on the inferior border 2.5 cm. medial to the insertion of the muscle into the femur. The procedure differs on the two sides. On the right side the dissector should detach the superior border of the muscle from the fascia on the glutæus medius at the point selected, and then pass one or two fingers downwards, on the deep surface of the muscle, along the line of incision. The part of the muscle thus freed from the deeper structures must then be divided with the scalpel, and the process must be repeated until the lower border of the muscle is reached. On the left side the dissector must commence at the inferior border, and, adopting the method above described, divide the muscle from below upwards. When the muscle is divided, reflect the lateral part to its insertion, the inferior fibres to their attachment to the gluteal tuberosity, the upper fibres to their attachment into the ilio-tibial tract. As the upper fibres of the muscle are followed to the aponeurotic insertion two bursæ will come into view, one between the aponeurotic insertion of the muscle and the lateral surface of the trochanter major, and a second, more distally placed, between the aponeurotic insertion and the lateral surface of the tendon of origin of the vastus medialis. Open both bursæ and examine their extents with the tip of the index finger. Then turn to the medial part of the muscle and reflect it towards its origin. As the reflection proceeds keep the edge of the scalpel close to the deep surface of the muscle to avoid injuring the posterior cutaneous nerve of the thigh, and as soon as the vessels and nerves which enter the deep surface of the muscle appear clean them and turn them medially with the muscle. As the upper part of the muscle is followed towards the ilium, branches of the superficial division of the superior gluteal artery will be met with, accompanied by their voluminous venæ comites. Clear the veins away, but keep the arteries. As the lower fibres are turned towards the tuberosity of the ischium branches of the inferior gluteal vessels and nerve will be found entering the deep surface of the muscle. Clear away the veins, but clean and keep the arteries and nerves. Between the muscle and the tuber ischii lies a mucous bursa. If it has not already been removed by the dissector of the perineum, open it. It is frequently multilocular, and its walls are closely attached by fibre strands to the glutæus maximus and to the tuberosity. Immediately medial and superior to the ischial tuberosity the deep fibres of the muscle spring from the superficial surface of the sacro-tuberous ligament; detach them carefully from the ligament and secure the perforating cutaneous nerve and the coccygeal branches of the inferior gluteal artery which pierce the ligament. The arteries must be divided in order that the reflection of the muscle can be continued, but the nerve should if possible be preserved. Continue the detachment of the muscle from the sacro-tuberous ligament until the margins of the sacrum and coccyx are reached, and as they are approached look for the posterior branches of the sacral nerves which form a plexus on the superficial surface of the ligament deep to the muscle.

The method of dissection suggested above is one best adapted to avoid injury to the branches of the inferior gluteal nerve which supplies the muscle; and it gives a view of the structures subjacent to the muscle similar to that obtained by the surgeon operating on the proximal part of the sciatic nerve.

The method of dissection previously adopted in this Manual was to detach the muscle from its origin from the ilium, the sacrum, the coccyx, and the sacro-tuberous ligament, and to throw it towards its insertion. That method also gives an excellent display of the subjacent structures, from a purely anatomical point of view, and the student who is dissecting the buttock for the second time might employ it with advantage, but it is not a plan which could be adopted by the surgeon. The dissector who employs that method must commence by clearing the upper and lower borders of the muscle. When that has been done the left hand must be insinuated between the muscle and the deeper structures, on the medial side of the greater trochanter, either from above or from below according to the side on which the limb is being dissected. Then, when the muscle has been gently raised from the deeper structures the reflection should be commenced, but the plan to be adopted is different on the two sides. On the left side the muscle must be detached from its origins from above downwards, commencing at the posterior part of the ilium. When the surface of the dorsum ilii from which it springs is cleared the upper margin of the greater sciatic notch is reached. There the dissector must proceed with caution, because through the notch pass the gluteal vessels, and their branches enter the deep surface of the glutæus maximus muscle. When these are secured the muscle must be detached from the side of the sacrum; then the piriformis muscle, emerging from under cover of the sacrum, comes into sight. The muscular fibres may now be raised from the surface of the sacro-tuberous ligament and separated from the side of the coccyx. As this is being done, care should be taken to preserve the three sacral cutaneous nerves intact, in order that they may be subsequently traced to their origins. As the surface of the sacro-tuberous ligament is gradually laid bare, a number of small arteries (the coccygeal branches of the inferior gluteal artery) will be seen piercing it and immediately sinking into the substance of the glutæus maximus. These cannot be retained. It is necessary to sever them in order that the muscle may be freed. The perforating cutaneous nerve, which winds round the lower border of the glutæus maximus near the coccyx, must also be remembered and traced to the sacro-tuberous ligament, which it will be seen to pierce.

On the right side commence the reflection in the reverse manner. Raise the muscle from the ischial tuberosity and

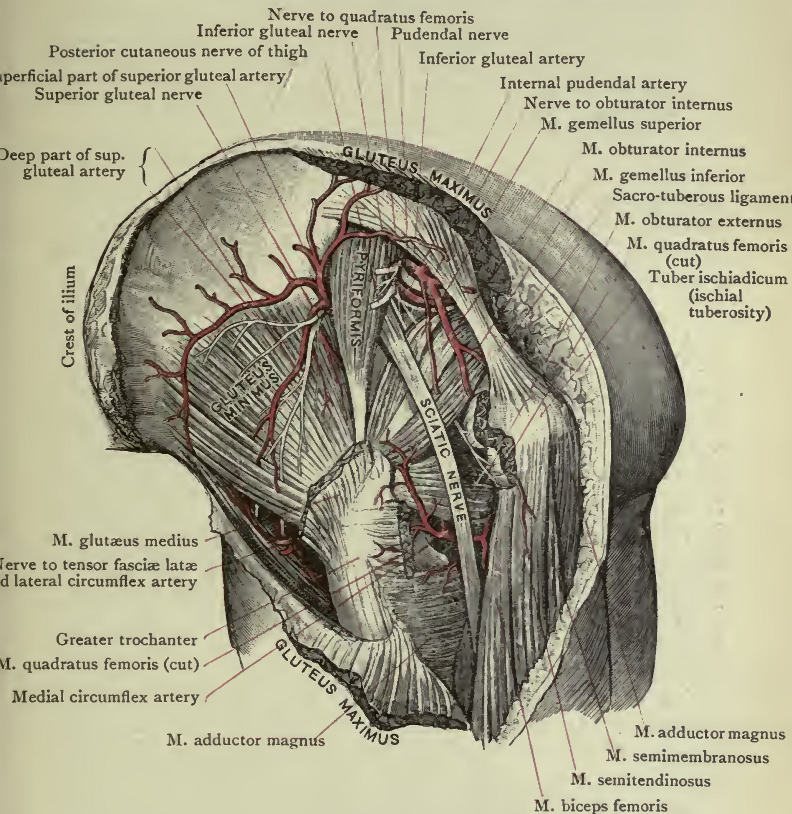


FIG. 129.—Dissection of the Gluteal Region. The Glutæus Maximus and the Glutæus Medius have been removed, and the Quadratus Femoris has been reflected.

separate it first from the coccyx, then from the sacro-tuberous ligament and the side of the sacrum, and finally from the ilium. Even when the muscle is completely separated from the parts from which it arises it still cannot be thrown towards its insertion, for it is tied to its place by blood-vessels and nerves which enter its deep surface. These are (1) the branches of the *superficial division* of the *superior gluteal artery*, which appear at the upper

border of the piriformis ; (2) branches of the *inferior gluteal artery* and the *inferior gluteal nerve* below the level of the piriformis. The venæ comites of the arteries may at once be removed, but the arteries and nerves must be cleaned as they come into view and followed into the substance of the glutæus maximus. Finally, in order to allow the complete reflection of the muscle, the arteries and nerves must be cut, but a small portion of the muscle should be left in connection with their cut ends so that they may be readily recognisable during the further stages of the dissection. The whole muscle can now be thrown distally and laterally, and, after a little dissection, an excellent view of its insertion can be obtained.

When the reflection of the muscle is completed note carefully the positions of the following parts: (1) the posterior border of the trochanter major; (2) the gluteal tuberosity which lies immediately distal to (1); (3) the tuberosity of the ischium; (4) the sacro-tuberous ligament.

The trochanter major is situated in the lower and lateral part of the area exposed by the reflection of the glutæus maximus. Immediately distal to it is the gluteal tuberosity into which the lower deep fibres of the glutæus maximus are inserted. The ischial tuberosity lies about 7 or 8 cm. medial to the distal part of the trochanter major. If the thigh is rotated laterally the trochanter is approximated to the tuberosity, and it recedes from the tuberosity when the thigh is rotated medially.[1] The sacro-tuberous ligament extends upwards and medially, from the tuberosity of the ischium to the margins of the sacrum and coccyx, and to the posterior inferior and superior spines of the ilium. The inferior border of the ligament is relatively straight. It forms the posterior boundary of the ischio-rectal fossa of the perineum, which has already been explored by the dissector of the abdomen. Its upper margin is curved, with the concavity directed forwards and upwards, and immediately in front of it are the greater and lesser sciatic foramina, which are separated from one another by the sacro-spinous ligament. The sacro-spinous ligament can be felt where it is attached to the spine of the ischium, 2.5 cm. above the upper border of the tuberosity of the ischium. Note also a group of muscles which are attached to the tuberosity and descend from it into the posterior region of the thigh. They are the hamstring muscles; do not clean them at present.

[1] The thigh is said to be rotated medially when its anterior surface is turned towards the median plane, and laterally when the anterior surface is turned away from the median plane.

Bursæ Mucosæ under cover of the Glutæus Maximus.— Three bursæ lie under cover of the glutæus maximus: one between its inferior margin and the ischial tuberosity, and two under cover of the aponeurotic part of its insertion, one between the aponeurosis and the trochanter major, and the other between the aponeurosis and the proximal part of the vastus lateralis.

The bursa between the ischial tuberosity and the glutæus maximus is frequently multilocular, being divided into several compartments by fibrous septa which pass from the bone to the deep surface of the muscle. The other two bursæ are unilocular, and not infrequently they communicate with one another.

On the second day after the body is turned on its face the dissector must examine the muscles, vessels, and nerves which lie directly subjacent to the glutæus maximus, as well as other structures situated in a deeper plane.

Before the work is commenced a pelvis with the ligaments *in situ* should be obtained and the skeletal peculiarities of the region should be studied. The interval between the posterior part of the hip bone and the margins of the sacrum and coccyx is divided into two foramina, the greater and lesser sciatic foramina, by two ligaments, the sacro-tuberous and the sacro-spinous. The sacro-tuberous ligament is the more superficial. It extends from the posterior part of the ilium and the margins of the lower part of the sacrum and the coccyx to the tuberosity of the ischium. The sacro-spinous ligament is partly covered by the sacro-tuberous ligament. It passes from the margin of the lower part of the sacrum and the margin of the coccyx to the spine of the ischium. The large foramen above the sacro-spinous ligament is the greater sciatic foramen. It lies below and behind the lower part of the ilium, and behind the upper part of the ischium. The foramen bounded above by the sacro-spinous and below by the sacro-tuberous ligament is the small sciatic foramen. It lies behind the lower part of the ischium. Through both foramina important structures pass to or from the gluteal region.

Emerging through the greater sciatic foramen are the piriformis muscle, the superior gluteal vessels and nerves, the inferior gluteal vessels and nerve, the posterior cutaneous nerve of the thigh, the sciatic nerve, the internal pudendal vessels, the pudendal nerve, the nerve to the obturator internus and superior gemellus, and the nerve to the quadratus femoris and inferior gemellus. Through the lesser sciatic foramen pass the obturator internus muscle, the pudendal nerve, the nerve to the obturator internus and the internal pudendal vessels (Fig. 129). All the structures mentioned, as well as other muscles, vessels, and nerves, have to be cleaned and examined. Therefore the second day's dissection is extensive and complicated, and unless it is proceeded with in a regular and definite manner it will not be successfully completed.

Dissection.—Commence with the superficial branches of the superior gluteal artery, which enter the upper part of the deep surface of the glutæus maximus, and follow them to the point where they emerge through the cleft between the border of the glutæus medius and the upper border of the adjacent piriformis muscle. Then clean the piriformis, from the great sciatic foramen, through which it emerges, to the greater trochanter, where its tendon disappears under cover of the glutæus medius. After the piriformis is defined, clean the posterior cutaneous nerve of the thigh, following it upward to its exit from the greater sciatic foramen at the lower border of the piriformis. Secure its perineal branch, which springs from its medial border and passes forwards and medially towards the perineum, anterior to the tuber ischii, and note the cutaneous branches which were seen on the lower part of the glutæus maximus. The posterior cutaneous nerve is sometimes accompanied by a branch of the inferior gluteal artery. If the inferior gluteal vessels and nerve, which lie medial to the posterior cutaneous nerve, were not displayed as the glutæus maximus was reflected, clean them now, and follow them to the lower border of the piriformis. When the inferior gluteal artery and its branches have been cleaned, place the leg on a large block to flex the knee, so that the structures in the buttock and the back of the thigh may be relaxed, then proceed to secure and clean the sciatic nerve. It is the large white firm cord which lies immediately deep to the posterior cutaneous nerve. Therefore pull the latter nerve medially with hooks, then at the level of the top of the trochanter major cut longitudinally through the fascia on the sciatic nerve till the nerve is exposed. Insert the handle of the scalpel into the incision in the fascia and run it upwards, along the *lateral border* of the nerve, to the greater sciatic foramen and downwards to the point where the nerve passes anterior to the biceps femoris and leaves the area of the present dissection. Clean the fascia from the back of the nerve from the lateral to the medial border, and secure the branches to the hamstring muscles, which spring from the medial border, at or a little distal to the level of the tuber ischii. Follow the branches to the muscles and preserve the branches of the medial femoral circumflex artery which join the nerves as they approach their terminations.

After the branches of the sciatic nerve to the hamstrings have been cleaned, pull the proximal part of the sciatic nerve laterally, to expose the nerve to the quadratus femoris, which lies between the sciatic nerve and the posterior surface of the ischium. The nerve to the quadratus femoris is frequently accompanied by a small branch of the inferior gluteal artery. On the medial side of the nerve to the quadratus femoris, lying on the spine of the ischium, find the nerve to the obturator internus, the internal pudendal vessels, and the pudendal nerve in that order from the lateral to the medial side. Clean away the venæ comites of the artery, but carefully preserve the artery itself and the nerves.

After the nerves and vessels mentioned have been identified and cleaned, proceed to the examination of the muscles which lie deep (anterior) to the sciatic nerve. They are, from above downwards, the superior gemellus, the obturator internus, the inferior gemellus, the quadratus femoris, and the proximal part of the adductor magnus. Emerging between the adjacent borders of the quadratus femoris and the adductor magnus the transverse terminal branch of the medial femoral circumflex artery will be found, and, piercing the adductor magnus at the medial border of the gluteal tuberosity of the femur, in a well-injected subject, the first perforating branch of the profunda artery may be seen. Clean the arteries, and then clean the muscles from above downwards. Note that the obturator internus emerges from the small sciatic foramen and that as it emerges it overlaps both the gemelli, whilst near the trochanter major, toward which all three muscles converge, the gemelli overlap the tendon of the obturator internus.

After the muscles are cleaned, divide the tendon of the obturator internus about 15 mm. from the lesser sciatic foramen. When the medial part of the tendon is raised and turned backwards the dissector will note that its deep surface is cleft into four or five strands, and that the margin of the lesser sciatic foramen, on which the tendon glides, is covered with smooth cartilage which is raised into ridges corresponding with the grooves on the deep surface of the tendon. A large bursa intervenes between the tendon and the bone.

Turn next to the hamstring muscles, which spring from the tuberosity of the ischium, and separate the common tendon of the biceps femoris and the semitendinosus from the flattened tendon of the semimembranosus, which lies immediately subjacent. Then pull the hamstrings laterally and display the origin of the adductor magnus from the inferior part of the tuber ischii.

Parts under Cover of the Glutæus Maximus.—Four groups of structures lie under cover of the glutæus maximus, viz., bursæ, muscles, vessels and nerves.

The bursæ, which have already been examined (see p. 291), are three in number; (1) a bursa between the middle of the inferior border of the glutæus maximus and the tuber ischii, (2) the bursa between the tendinous insertion of the glutæus maximus and the trochanter major, and (3), immediately distal to the last, the bursa between the tendinous insertion of the glutæus maximus and the vastus lateralis.

The muscles met with between the dorsum ilii above and the tuber ischii and the posterior area of the thigh

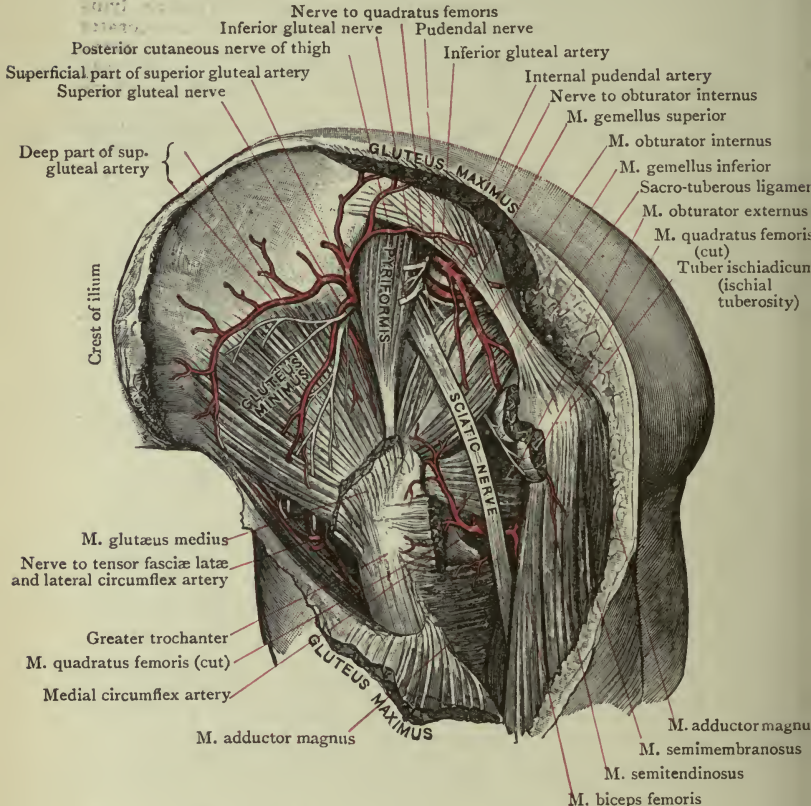


FIG. 130.—Dissection of the Gluteal Region. The Glutæus Maximus and the Glutæus Medius have been removed, and the Quadratus Femoris has been reflected.

below are:—(1) The posterior part of the glutæus medius; (2) the piriformis, issuing from the pelvis through the greater sciatic foramen; (3) the tendon of the obturator internus, passing through the lesser sciatic foramen; (4) the gemellus superior, attached to the upper border of the obturator internus; (5) the gemellus inferior, attached to the inferior border of the obturator internus; (6) the quadratus femoris, attached medially to the ischial tuberosity and laterally to the distal part of the trochanter major, and to the proximal part of the body of the femur; (7) the proximal part of the adductor magnus, immediately distal to the quadratus femoris; (8, 9, and 10) the biceps femoris, the semitendinosus and the semimembranosus (hamstrings), springing from the tuberosity of the ischium. In addition to the above-mentioned muscles the dissector should note (11) that the proximal part of the vastus lateralis is under cover of the tendinous insertion of the glutæus maximus, distal to the lateral part of the trochanter major, and (12 and 13) that the lower and medial part of the glutæus maximus, which forms the posterior boundary of the ischio-rectal fossa, is separated by a pad of fat from the levator ani and the coccygeus muscles, which form the medial wall of the fossa.

The vessels and nerves under cover of the glutæus maximus are also numerous; they are:—

(1) Issuing between the adjacent borders of the glutæus medius and piriformis and passing into the deep surface of the glutæus maximus, *superficial branches of the superior gluteal artery*. The trunk from which the branches spring, and the superior gluteal nerve, which accompanies it, can be seen if the borders of the muscles are separated.

(2) In the interval between the lower border of the piriformis and the upper border of the superior gemellus two arteries and six nerves emerge through the greater sciatic foramen into the buttock, viz.:—

Arteries,	1. Arteria glutæa inferior. 2. Arteria pudenda interna.
Nerves,	1. Nervus glutæus inferior. 2. Nervus cutaneus femoris posterior. 3. Nervus ischiadicus. 4. Nervus pudendus. 5. Nerve to the obturator internus. 6. Nerve to the quadratus femoris.

(3) In the interval between the gemellus inferior and the quadratus femoris, the *ascending terminal branch* of the *medial femoral circumflex artery* will be seen.

(4) At the distal border of the quadratus femoris the *transverse terminal branch* of the *medial femoral circumflex artery* passes backwards to the hamstring muscles; and the first perforating

branch of the profunda artery pierces the adductor magnus close to the distal part of the gluteal tuberosity of the femur.

Nervus Glutæus Inferior.—The inferior gluteal nerve is the nerve of supply to the glutæus maximus. It springs from the sacral plexus, and enters the gluteal region through the lower part of the great sciatic foramen. When the glutæus maximus was reflected the nerve was seen breaking up into numerous twigs which entered the deep surface of the muscle.

Arteria Glutæa Inferior (O.T. **Sciatic**).—The inferior gluteal artery, a branch of the hypogastric artery (O.T. internal iliac), issues from the pelvis, through the great sciatic foramen, below the piriformis muscle, and proceeds distally, with the sciatic nerve, under cover of the glutæus maximus, in the hollow between the greater trochanter and the ischial tuberosity. At the lower border of the glutæus maximus it is continued, as a fine cutaneous twig, to the posterior aspect of the thigh, in company with the posterior cutaneous nerve. It gives off numerous branches in the gluteal region. Of these the large muscular offsets to the glutæus maximus, and the cutaneous twigs that accompany the branches of the posterior cutaneous nerve of the thigh which turn round the distal border of that muscle, have been already studied. The following three branches remain to be examined:—(1) the *coccygeal branch*, which passes medially between the sacro-tuberous and sacro-spinous ligaments to reach the integument and fascia in the region of the coccyx; a number of twigs derived from this branch have been previously noticed piercing the sacro-tuberous ligament and ending in the glutæus maximus; (2) *arteria comitans nervi ischiadici*, a minute artery, which runs distally on the sciatic nerve and finally penetrates into its substance; (3) the *artery to the quadratus femoris*, which accompanies the nerve to that muscle; it will be found lying on the hip bone under cover of the sciatic nerve.

In a well-injected body the anastomosis between the inferior gluteal artery, the two terminal branches of the medial circumflex artery, and the first perforating artery may be made out.

Nervus Cutaneus Femoris Posterior (O.T. **Small Sciatic Nerve**).—The posterior cutaneous nerve of the thigh arises, within the pelvis, from the sacral plexus. After escaping through the greater sciatic foramen it extends distally, with the inferior gluteal artery, under cover of the glutæus maximus. From the inferior border of the glutæus maximus it proceeds distally, on the back of the thigh, immediately subjacent to the deep fascia. It will afterwards be traced to the posterior aspect of the calf of the leg.

In the gluteal region it gives off several cutaneous branches,

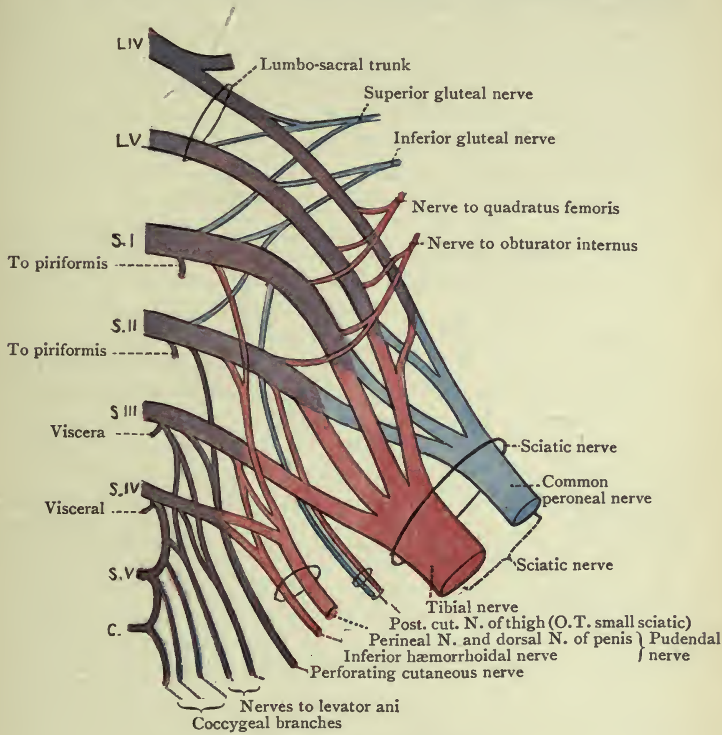


FIG. 131.—Diagram of Sacral Plexus.

viz.—(1) inferior nerves of the buttock, which wind round the inferior border of the glutæus maximus to supply a limited area of the skin of the buttock; (2) a few twigs to the skin to the medial region of the thigh; and (3) the perineal branches, of which one is known as the *long perineal nerve* (O.T. *long pudendal*). This branch turns medially, round the origin of the hamstring muscles, to reach the perineum.

Nervus Ischiadicus (O.T. Great Sciatic Nerve).—The sciatic nerve, the largest nerve in the body, comes from the sacral plexus, and enters the gluteal region through the lower part of the great sciatic foramen. At first it has the form of a flattened band, but soon it becomes oval or round, as seen in section. Covered by the glutæus maximus, the sciatic nerve traverses the gluteal region in the interval between the greater trochanter of the femur and the tuberosity of the ischium. From above downwards it lies on the body of the ischium and the nerve to the quadratus femoris, the tendon of the obturator internus with the two gemelli muscles, the quadratus femoris, and the adductor magnus. The nerves to one or more of the hamstring muscles issue from the main trunk near the lower border of the glutæus maximus.

The sciatic nerve frequently escapes from the pelvis in the form of two trunks (the two divisions into which it normally divides in the thigh, viz., the tibial and the common peroneal) which enclose between them a portion of the piriformis muscle.

Arteria Pudenda Interna, Nervus Pudendus (O.T. Internal Pudic), and the Nerve to the Obturator Internus.—The internal pudendal artery, the pudendal nerve and the nerve to the obturator internus muscle are exposed, in the present dissection, only in a very short part of their extent. They all emerge from the greater sciatic foramen and cross the spine of the ischium or the adjacent part of the sacro-spinous ligament; then they enter the lesser sciatic foramen and pass out of view. The *nerve to the obturator internus* is placed most laterally. It lies on the base of the ischial spine, and furnishes a twig to the gemellus superior. The *internal pudendal artery*, with a companion vein on each side, crosses the tip of the spine. The *pudendal nerve* is placed most medially, and lies on the sacro-spinous ligament, close to its attachment to the spine. In some cases, however, the pudendal nerve unites in a plexiform manner with the nerve to the obturator internus, so that the whole, or a part, of it may lie lateral to the pudendal vessels.

Small Lateral Rotator Muscles of the Thigh.—Under this heading are included the piriformis, the obturator internus, and the two gemelli, the quadratus femoris, and the obturator externus. They all lie directly under cover of the glutæus maximus in the greater part of their extent, except the obturator externus which lies deep (anterior) to the quadratus femoris, and cannot be properly seen from behind until that muscle has been reflected; they are all inserted into, or in the neighbourhood of, the greater trochanter of the femur, and they are applied to the posterior surface of the capsule of the hip joint. The first five are lateral rotators of the thigh, when the hip joint is extended, but they become abductors when the joint is flexed. The obturator externus is a lateral rotator in both positions.

M. Piriformis.—The piriformis arises within the pelvis from the three middle pieces of the sacrum, and slightly from the upper margin of the great sciatic notch of the hip bone. The sacral origin cannot be seen at present, but the iliac origin should be made out. After it has passed through the great sciatic foramen, the muscle is directed downwards, laterally, and forwards. Its fleshy belly rapidly tapers and it ends in a rounded tendon, which crosses superficial to the common tendon of the obturator internus and gemelli, and is inserted into a small impression on the highest part of the greater trochanter of the femur (Fig. 117, p. 262). It is closely adherent to the subjacent obturator tendon for some distance. The piriformis is supplied by branches from the *first* and *second sacral nerves.*

Mm. Obturator Internus et Gemelli.—These muscles, together, constitute a tricipital muscle with one large intra-pelvic belly (obturator internus), and two small extra-pelvic bellies (gemellus superior and inferior). The common tendon is inserted into an impression on the upper part of the greater trochanter of the femur, immediately posterior to and below the insertion of the piriformis (Fig. 117, p. 262).

The *gemellus superior* arises from the spine of the ischium, at the upper margin of the small sciatic notch. Its fibres pass laterally, along the superior border of the tendon of the obturator internus, and are inserted obliquely into that tendon.

The *gemellus inferior* arises from the tuberosity of the ischium, at the lower margin of the lesser sciatic notch, and is inserted into the lower border of the obturator tendon, in a similar manner to the gemellus superior. Close to their origins the gemelli meet under cover of the obturator tendon, and form a fleshy bed on which the tendon lies; near the trochanter the fibres of the gemelli overlap the obturator tendon, and tend to cover its superficial surface.

The *tendon of the obturator internus* has already been divided and the peculiarities of its deep surface have been examined (see p. 293).

M. Quadratus Femoris.—The quadratus femoris lies between the gemellus inferior and the adductor magnus. It arises from the lateral border of the ischial tuberosity, and proceeds horizontally to gain insertion into the quadrate tubercle, and into a line which extends distally from it, on the back of the femur, for about two inches (Figs. 121, 122).

Dissection.—The nerve to the quadratus femoris should now be traced to its termination. It lies deep to the two gemelli, the obturator internus, and the quadratus femoris. The obturator internus has already been divided. Now divide the two gemelli muscles, lateral to the nerve. Raise the medial parts and follow the nerve behind them. As the inferior gemellus is approached secure the twig which the nerve supplies to it. Lastly, divide the flat quadratus femoris, midway between the tuberosity of the ischium and the femur and throw the two parts aside. When the dissection is completed not only is the whole length of the nerve to the quadratus femoris exposed, but also a considerable portion of the posterior aspect of the capsule of the hip joint is laid bare; further, part of the obturator externus muscle, the termination of the medial circumflex artery, and the insertion of the ilio-psoas are brought into view. The exposed posterior part of the capsule of the hip joint consists largely of circularly arranged fibres.

Nerve to the Quadratus Femoris.—The small nerve to the quadratus femoris runs distally on the hip bone and passes successively anterior to the following structures: the sciatic nerve, the gemellus superior, the tendon of the obturator internus, the gemellus inferior. It gives the nerve of supply to the gemellus inferior and a twig to the hip joint, and ends by sinking into the deep surface of the quadratus femoris.

M. Obturator Externus.—The terminal part of the obturator externus muscle can now be seen winding round the neck of the femur. It ends in a rounded tendon which is implanted into the fossa trochanterica of the femur (Fig. 122, p. 271). Its origin has already been examined (p. 277).

Arteria Circumflexa Femoris Medialis.—The medial circumflex artery comes to an end at the proximal border of the adductor magnus by dividing into its ascending and transverse terminal branches. The *ascending branch* runs obliquely upwards and laterally, anterior to the quadratus femoris and upon the posterior surface of the obturator externus. Its terminal twigs ramify in the neighbourhood of the trochanteric fossa, where they anastomose with twigs from the inferior and superior gluteal arteries. The *transverse branch* passes posteriorly, between the quadratus femoris and the adductor magnus, and enters the hamstring muscles. It anastomoses with the terminal twig of the middle division of the lateral circumflex artery, which, in a well-injected subject, will be noticed appearing from amidst the fibres of the proximal part of the vastus lateralis. An arterial circle is thus completed, around the proximal part of the femur; it communicates proximally with the inferior gluteal artery and distally with the first perforating artery. This series of inosculations is sometimes spoken of as the *crucial anastomosis* of the thigh.

The dissector has now examined all the structures in the gluteal region which lie below the level of the piriformis. He should, in the next place, turn his attention to that portion of the dissection which lies above the level of that muscle. There he will find several structures which lie in close relation to the dorsum ilii. These are the glutæus medius, the glutæus minimus, and the tensor fasciæ latæ, together with the blood-vessels and nerve which supply them, viz., the superior gluteal artery and vein, and the superior gluteal nerve.

The posterior part of the glutæus medius muscle was covered by the glutæus maximus. Its anterior border is overlapped by the tensor fasciæ latæ, and the intermediate area is invested by the dense fascial layer already referred to.

***Dissection.*—Remove the fascia from the superficial surface of the glutæus medius and pull the tensor fasciæ latæ forward.**

M. Glutæus Medius.—The glutæus medius arises from that part of the dorsum ilii which is bounded above by the posterior curved line and the anterior four-fifths of the crest of the ilium, and below by the anterior gluteal line (Fig. 128, p. 286); it derives fibres also from the strong fascia which covers it. The fibres converge to form a flattened band, partly fleshy and partly tendinous, which is inserted into an oblique line on the lateral aspect of the greater trochanter of the femur, and into the surface immediately above it. The glutæus medius muscle is supplied by the *superior gluteal nerve.* As a whole the muscle is an abductor of the thigh, but its anterior fibres can rotate the thigh medially, and the posterior fibres can rotate it laterally.

Dissection.—The glutæus medius must now be reflected. Keep the tensor fasciæ pulled well forward. Insert the fingers between the posterior borders of the glutæus medius and minimus, and separate the muscles, from behind forwards, to their anterior margins, which were exposed and defined in the dissection of the anterior part of the thigh (see p. 249). Then divide the medius two inches above the trochanter major. Turn the lower part towards the trochanter, into which it is inserted, and the upper part towards its origin from the ilium. As the lower part of the muscle is reflected to its insertion into the oblique line on the lateral surface of the trochanter major, a small bursa will be displayed between the muscle and the upper and anterior part of the lateral surface of the trochanter. When the upper part of the muscle is raised, towards its origin, the branches of the superior gluteal vessels and the superior gluteal nerve, which lie between the glutæus medius and minimus, will be exposed; they must be carefully cleaned and preserved, except the smaller twigs which enter the deep surface of the glutæus medius which may be cut if they interfere with the reflection of the muscle. As the branches of the artery and nerve are followed the superficial surface of the glutæus minimus must be cleaned.

Nervus Glutæus Superior.—After emerging from the pelvis, through the greater sciatic foramen, the superior gluteal nerve turns forward, between the glutæus medius and minimus, and immediately divides into an upper and a lower branch. The upper branch follows the upper border of the glutæus minimus and it gives branches to the glutæus medius. The lower branch of the nerve crosses the middle of the glutæus minimus with the lower branch of the superior gluteal artery. It supplies branches to both the glutæus medius and minimus, then passes between the anterior borders of those two muscles and ends in the tensor fasciæ latæ.

Arteria Glutæa Superior.—The superior gluteal artery is a large vessel which springs from the hypogastric artery and escapes from the pelvis, through the upper part of the great sciatic foramen, above the level of the piriformis.

Immediately after its exit, it divides into a superficial and a deep division. The *superficial division* has been already seen during the reflection of the glutæus maximus. Its branches are distributed to the deep surface of that muscle.

The *deep division* bifurcates, close to its origin, into a superior and an inferior branch, which run forwards between the glutæus medius and minimus. The *superior branch* follows accurately the anterior gluteal line on the dorsum ilii, and, at the anterior superior spine, terminates by anastomosing with the superficial and deep circumflex iliac arteries, and with the ascending branch of the lateral femoral circumflex artery. The latter has already been noticed passing proximally under cover of the tensor fasciæ latæ. The *inferior branch* runs forwards across the middle of the glutæus minimus, with the inferior branch of the superior gluteal nerve. It supplies the two gluteal muscles between which it lies and the tensor fasciæ latæ. It gives twigs to the hip joint, and others of its branches anastomose with twigs of the ascending branch of the lateral femoral circumflex artery.

M. Glutæus Minimus.—The glutæus minimus muscle arises from the broad area on the dorsum ilii, which is included between the anterior and inferior curved lines (Fig. 128, p. 286). The muscular fibres pass gradually into an aponeurotic tendon, which covers the superficial surface of the distal part of the muscle. The tendon, as it passes distally, narrows into a flattened band, which is inserted into a special impression on the lower and lateral part of the anterior aspect of the greater trochanter of the femur (Figs. 117, 118, p. 262). It is intimately connected, near its insertion, with the capsule of the hip joint, and it is separated from the upper and anterior part of the trochanter major by a small bursa. The glutæus minimus is supplied by the *superior gluteal nerve*. Its actions are the same as those of the glutæus medius (see p. 301).

***Dissection.*—After the superior gluteal vessels and nerve have been studied the glutæus minimus must be reflected. Detach it from its origin and turn it downwards.**

Parts under Cover of the Glutæus Minimus.—As the glutæus minimus is reflected three structures are displayed:—(1) part of the capsule of the hip joint; (2) the reflected tendon of the rectus femoris; and (3) the bursa between the tendon of the glutæus minimus and the upper part of the anterior aspect of the greater trochanter. The bursa should be opened in order that its extent may be examined.

At this stage the dissector should examine not only the part of the capsule of the hip joint exposed by the reflection of the glutæus minimus, but also the parts exposed by the reflection of the quadratus femoris (see p. 300), and the obturator internus (see p. 293); collectively they are the upper and posterior portions. They are all loosely attached to the back and upper part of the neck of the femur, about a finger's breadth medial to the trochanter, but they are firmly attached to the acetabular rim. Many of the fibres of the posterior part of the capsule run circularly round the neck of the femur. Others run parallel with the neck, at right angles to the circular fibres, and in the lower part of the capsule, which is covered by the obturator externus, is a band of fibres, the *ischio-capsular band*, which runs upwards and laterally parallel with the course of the obturator externus.

The reflected tendon of the rectus femoris is attached to the floor of a groove situated immediately above the upper part of the margin of the acetabulum, and is there embedded in the superficial fibres of the capsule which must be removed, to expose it, by cutting through them parallel with the direction of the tendon.

FOSSA POPLITEA (POPLITEAL SPACE).

The popliteal fossa should be dissected, if possible, before the posterior region of the thigh is disturbed, in order that its contents may be examined before the medial and lateral boundaries of its proximal portion are displaced from their positions. During the dissection the following structures will be met with :—

1. Superficial fascia.
2. The small saphenous vein.
3. The posterior cutaneous nerve of the thigh.
4. Popliteal fascia.
5. Muscles which bound the fossa. { Biceps femoris. Semitendinosus. Semimembranosus. Gastrocnemius. Plantaris.
6. The tibial and common peroneal nerves and their branches.
7. The popliteal artery and vein and their branches and tributaries.
8. A few lymph glands.
9. A slender branch from the obturator nerve.
10. The popliteus muscle.

Surface Anatomy.—The area of the popliteal fossa is popularly called *the ham*. It is situated in the posterior region of the knee, and it lies behind the distal third of the femur, the knee joint, and the proximal fifth of the tibia. It appears as a hollow when the knee joint is flexed, but forms a slight prominence when the joint is fully extended.

In the sides of the area, about the middle of its length, the condyles of the femur are easily distinguished; distal to them lie the condyles of the tibia. The head of the fibula is posterior and a little distal to the most projecting part of the lateral condyle of the tibia.

The tendons which form the medial and lateral boundaries of the proximal part of the popliteal fossa are the tendons of the hamstring muscles; the biceps femoris on the lateral side and the semitendinosus and semimembranosus on the medial side. They can be seen in both the extended and flexed positions of the knee, but they are most obvious when the knee is flexed. When the knee is flexed and deep pressure is made in the middle of the hollow between the hamstring tendons, the (injected) popliteal artery can be distinguished, and in the living subject the pulsations of the artery can be felt. The biceps tendon should be followed to its insertion into the head of the fibula whilst the knee is flexed, then the knee should be extended. When that has been done and pressure is made immediately above the head of the fibula, at the anterior border of the biceps tendon, the proximal part of the cord-like fibular collateral ligament of the knee joint may be distinguished, whilst, on the medial side of the posterior border of the biceps tendon, the common peroneal nerve can be felt. When a little care is exercised the nerve can be rotated against the posterior part of the lateral condyle of the femur, but palpation of the nerve is more easily done in the living than the dead body. The nerve should be followed to the back of the head of the fibula where it can be pressed against the proximal part of the soleus muscle. When the knee joint is extended the rounded tendon of the adductor magnus can be felt, as it passes to its insertion into the adductor tubercle, which lies on the upper border of the medial condyle at the distal end of the medial supracondylar ridge. The adductor tubercle is an important practical landmark, for it indicates the plane of junction of the body of the femur with the distal epiphysis.

In muscular subjects the two heads of the gastrocnemius muscle form prominent rounded cushions which extend from the distal part of the popliteal area into the proximal part of the posterior region of the leg.

Proximal to the popliteal region the posterior region of the thigh presents a smooth rounded surface, on which, in thin subjects, indications of the outlines of the bellies of the hamstring muscles may be seen.

Dissection.—Reflection of the Skin.—Place a block under the knee to support the limb and to render tense the muscles which form the boundaries of the popliteal fossa. *Incisions*—(1) A vertical incision along the median line of the limb from the junction of the middle and distal thirds of the thigh to the junction of the proximal fourth with the distal three-fourths of the leg. (2) A transverse incision at the proximal end of the vertical incision. (3) A transverse incision at the distal end of the vertical incision. Each of the two transverse incisions should extend halfway round the limb.

The two flaps of skin defined by the incisions (21 and 22, Fig. 126) must be separated from the superficial fascia and turned to their respective sides.

Superficial Fascia—Vena Saphena Parva (O.T. **External Saphenous Vein)—Branches of the Posterior Cutaneous Nerve of the Thigh** (O.T. **Small Sciatic).**—When the skin is reflected the fatty layer of the superficial fascia of the popliteal region is brought into view. It presents no peculiar features, and, as a rule, it contains only a moderate amount of fat, amidst which the following structures must be sought: (1) The proximal part of the *small saphenous vein*; (2) the terminal part of the posterior cutaneous nerve of the thigh; (3) branches of the posterior cutaneous nerve of the thigh; (4) the posterior branch of the medial cutaneous nerve of the thigh; (5) the anastomotic peroneal nerve.

Dissection.—Look first for the small saphenous vein. It ascends along the middle line of the back of the calf and pierces the deep fascia over the distal part of the popliteal fossa. As the proximal part of the vein is being cleaned secure the terminal part of the posterior cutaneous nerve of the thigh which runs alongside of the vein. At a higher level, in the fat in the middle line of the proximal part of the popliteal area one or more twigs from the posterior cutaneous nerve of the thigh may be found, piercing the deep fascia on their way to the skin.

When the medial side of the thigh was dissected the posterior branch of the medial cutaneous nerve of the thigh was found descending along the posterior border of the sartorius muscle (Fig 127). It should be followed now as it descends behind the medial boundary of the popliteal fossa to the back of the calf. The peroneal anastomotic nerve may be found at the lower and lateral part of the popliteal area as it pierces the deep fascia covering the lateral head of the gastrocnemius muscle (Fig. 127). In some cases, however, the nerve pierces the deep fascia at a much more distal level. In such cases it will not be found until the back of the leg is dissected. After the small saphenous vein and the nerves mentioned have been secured and cleaned, remove the remains of the superficial fascia, but be careful to avoid injury to the deep fascia which is somewhat thin.

Fascia Poplitea (Popliteal Fascia).—Although it is thin, the deep fascia of the popliteal region possesses considerable strength owing to the transverse fibres which are interwoven amidst its longitudinal fibres. As the dissector removes the fascia he will notice that it is firmly attached on each side to the tendons of the muscles which bound the fossa poplitea. Proximally, it is continuous with the fascia lata of the thigh.

Before the popliteal fascia is interfered with the dissector is recommended to read the following two paragraphs, which deal in a general way with the boundaries and contents of the popliteal fossa.

Boundaries. — The popliteal fossa is diamond-shaped. Proximally and laterally it is bounded by the *biceps femoris muscle*; whilst proximally and medially are the *semitendinosus* and the *semimembranosus muscles*, the former lying upon the posterior surface of the latter. On the medial side of the knee, anterior to the semimembranosus, lie the *gracilis*, the *sartorius*, and the tendon of the *adductor magnus*. The fossa is bounded, distally, by the converging heads of the *gastrocnemius*. In the formation of the distal and lateral boundary the lateral head of the gastrocnemius is assisted by the small *plantaris muscle*.

Contents of the Fossa.—The principal objects within the popliteal fossa are the *tibial* and *common peroneal nerves* and the *popliteal artery* and *vein*, with their branches and tributaries, but the most superficial structure, in the proximal part of the space, is the *posterior cutaneous nerve of the thigh*, which runs along the middle line, immediately subjacent to the popliteal fascia, until it pierces that fascia in the distal part of the space. Separated from the posterior cutaneous nerve of the thigh by a thin layer of fat is the large tibial nerve. It lies superficial to the popliteal vein and artery which are situated in a much deeper plane in close contact with one another. The common peroneal nerve lies along the upper lateral boundary of the fossa, under cover of the posterior margin of the biceps femoris. Both the tibial and the common peroneal nerves give off branches of which the majority are easily found, but their articular twigs are delicate and are easily destroyed by the dissector who does not exercise sufficient care. One of the articular nerves, however, is derived neither from the tibial nor the common peroneal nerve, but from the deep division of the obturator nerve previously dissected (p. 273). It descends in close apposition to the popliteal artery. Other important contents of the fossa are lymph-glands, some of which lie relatively superficial, near the point where the small saphenous vein

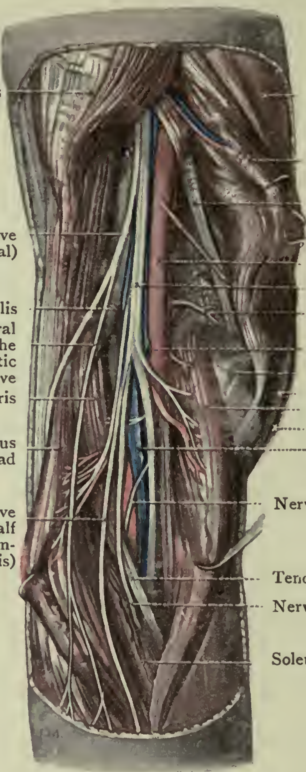


FIG. 132.—Dissection of the Left Popliteal Fossa. The proximal boundaries have been pulled apart and the aponeurosis into which the two heads of the gastrocnemius is attached has been split and the heads have been displaced to their respective sides.

pierces the popliteal fascia, but the majority are deeply placed adjacent to the popliteal vein and artery.

Dissection.—**Do not attempt to open up the popliteal fossa and display its contents until its proximal boundaries have been cleaned and their relationships to the fossa have been defined.**

The distal boundaries will be cleaned and displayed as some of the contents of the fossa are secured and followed towards their terminations.

Clean first the proximal lateral boundary. Make an incision through the deep fascia along its medial margin, turn the fascia laterally and expose the biceps femoris. Clean the muscle and its tendon, follow the tendon to its insertion into the head of the fibula, and note that at the level of the knee the biceps femoris crosses the lateral head of the gastrocnemius. After the distal part of the biceps femoris has been cleaned, turn to the proximal medial border of the space; make an incision through the deep fascia along its lateral margin, and reflect the fascia covering it towards the medial side to expose the semitendinosus and semimembranosus muscle; follow the tendon of the more superficial semitendinosus muscle to the level of the medial condyle of the tibia. Then pull the semitendinosus aside and clean the distal part of the semimembranosus, and follow its tendon to its insertion into the medial condyle of the tibia. Preserve if possible the muscular branches of the popliteal artery which enter the lateral part of the muscle, and note that the tendon of insertion springs mainly from the lateral border and anterior (deep) surface of the muscle. Pull the part of the muscle which lies at the level of the medial condyle of the femur towards the medial side of the knee and display the semimembranosus bursa, which lies between the semimembranosus and the medial head of the gastrocnemius as they cross one another. The semimembranosus bursa often communicates, round the medial border of the gastrocnemius, with a bursa which lies between the medial head of the gastrocnemius and the back of the knee joint, and that, in turn, communicates with the cavity of the knee joint. Open the bursa and, if possible, display the communications which have been mentioned with the aid of a probe. Now pull the semitendinosus and semimembranosus laterally and clean the gracilis, which lies medial and anterior to them. At the anterior border of the gracilis the saphenous nerve emerges between the gracilis and the posterior border of the sartorius accompanied by the saphenous branch of the arteria genu suprema; secure the artery and nerve and follow them downwards to the medial border of the tibia and note that they accompany the *great* saphenous vein, which was exposed when the medial side of the thigh was dissected. Then pull the gracilis medially and clean the distal part of the adductor magnus which lies lateral to it.

When the proximal boundaries of the fossa have been cleaned and examined, seize the posterior cutaneous nerve of the thigh at the point where it pierces the popliteal fascia (see p. 306), and follow it to the proximal angle of the fossa, dividing the popliteal fascia which lies superficial to it; then remove the remains of the popliteal fascia from the proximal part of the popliteal area. Now pull the posterior cutaneous nerve aside, with a hook, and cut through the fat in the proximal apex of the fossa till the large tibial nerve is exposed. Follow the tibial nerve distally, cleaning it, partly with the aid of the handle of the scalpel and partly by occasional touches with the point of the scalpel, and secure its cutaneous, muscular, and articular branches. Its cutaneous branch, *the medial cutaneous nerve of the calf*, arises from its posterior aspect and descends between the two heads of the gastrocnemius. Follow that branch to the distal angle of the fossa, dividing the popliteal fascia superficial to it. The articular branches are three in number, *superior medial genicular*, *inferior medial genicular*, and *middle genicular.* All three branches spring from the medial side of the tibial nerve, the superior branch at or above the proximal angle of the fossa, and the other two at more distal levels. Each joins a corresponding branch of the popliteal artery, and is distributed with it. The superior branch leaves the fossa above the medial condyle of the femur, the inferior branch turns medially below the medial condyle of the tibia, and the middle branch pierces the posterior ligament of the knee joint. The *muscular branches* arise about the middle of the fossa and pass to the two heads of the gastrocnemius, the plantaris, the soleus, and the popliteus ; the heads of the gastrocnemius must be separated to obtain a proper view of these branches. The branch to the soleus will be recognised because it passes between the plantaris and the lateral head of the gastrocnemius. The nerve to the popliteus lies deeply in the angle between the heads of the gastrocnemius superficial to the popliteal artery. It will be followed to its termination in a subsequent dissection (see p. 403).

When the tibial nerve and its branches have been cleaned return to the proximal angle of the fossa, dissect in the fat lateral to the tibial nerve at the medial border of the biceps, and secure the common peroneal nerve. It descends along the medial border of the biceps, and leaves the fossa at the lateral angle, crossing superficial to the plantaris and the lateral head of the gastrocnemius (Fig. 132). Follow the nerve carefully from above downwards. Whilst it is in the fossa it gives off two articular branches, *superior lateral genicular*, and *inferior lateral genicular*, and a cutaneous branch, the *anastomotic peroneal nerve*, which crosses the lateral head of the gastrocnemius. As the common peroneal nerve lies superficial to the lateral head of the gastrocnemius it gives off the *lateral cutaneous nerve of the calf* ; then it passes posterior to the head of the fibula, from which it is separated by the highest fibres of the soleus, and disappears between the peroneus longus and the neck of the fibula. The superior lateral articular branch leaves the fossa proximal to the lateral condyle of the femur with the corresponding branch of the popliteal artery. The inferior lateral articular branch joins the inferior lateral genicular branch of the popliteal artery at the lateral side of the knee between the head of the fibula and the lateral condyle of the femur. The lateral cutaneous nerve of the calf and the anastomotic peroneal cutaneous branch sometimes arise from the common peroneal nerve by a common stem (see Fig. 132). When the nerves mentioned have been found and cleaned, clean the two heads of the gastrocnemius and separate the plantaris from the medial border of the lateral head, taking care not to injure the nerve to the soleus which passes between the plantaris and the lateral head of the gastrocnemius. As the muscles are cleaned, note the branches of the popliteal artery which pass to them, but divide those branches if they interfere with the separation of the muscles.

The popliteal vein and its tributaries and the popliteal artery and its branches must now be cleaned. Pull the tibial nerve laterally and clear away the fat on the lateral side of the semimembranosus at the proximal part of the fossa. The artery enters the fossa a little distal to the proximal angle, on the medial side, where it lies close to the *floor* or anterior boundary of the fossa. It leaves the fossa at the distal angle at the distal border of the popliteus muscle. In the proximal part of the fossa the vein is lateral to the artery. In the middle part of the fossa it is posterior to the artery, and in the distal part it is medial to the artery, always intervening between the artery and the tibial nerve. In the angle between the artery and the vein, in the proximal part of the fossa, look for the slender genicular branch of the obturator nerve, and, having secured it, follow it to the point where it pierces the posterior ligament of the knee joint with the middle genicular artery. Then proceed to clean the popliteal artery and its branches and the popliteal vein. Not uncommonly in addition to the main vein, whose position has been described, there are two or more accessory venous channels which communicate with the main vein and anastomose with one another round the artery ; if they are present clear them away, but take care, whilst doing so, not to injure the branches of the artery. The branches of the artery to the hamstring muscles and the muscles of the calf are numerous, and, if they interfere with the cleaning of the main structures, they must be divided, but the articular branches must be carefully preserved ; they are five in number, the superior and inferior medial genicular arteries, the superior and inferior lateral genicular arteries, and the middle genicular artery. They all lie close to the floor of the space and are liable to be injured as the soft fat around the popliteal artery is cleared away. The superior genicular branches lie at the level of the proximal borders of the condyles of the femur. They run transversely and they leave the space, the medial by piercing the posterior intermuscular septum of the thigh, and the lateral by piercing the lateral intermuscular septum. The inferior lateral genicular artery also runs transversely, at the level of the interval between the lateral condyle of the femur and the head of the fibula, but the inferior medial genicular branch descends obliquely, deep to the medial head of the gastrocnemius, and then turns forwards, distal to the medial condyle of the tibia. The middle genicular artery accompanies the genicular branch of the obturator nerve through the middle part of the posterior ligament of the knee joint. The final step of the dissection is the cleaning of the fat from the floor of the fossa. With the handle of the scalpel scrape the fat away from the posterior surface of the femur, the posterior ligament of the knee joint, and the posterior surface of the fascia covering the popliteus, taking care not to injure the genicular arteries.

Floor of the Fossa.—The floor is formed proximo-distally by—(1) the popliteal surface of the femur ; (2) the oblique popliteal ligament of the knee joint ; and (3) by the strong fascia which covers the popliteus muscle.

The Fossa Poplitea as seen in a Section through the Frozen Knee.—The diamond-shaped space on the back of the knee joint which is brought into view by dissection differs widely from the condition which is observed when transverse sections are made through this part of the frozen limb (Fig. 133). Before the integuments and fasciæ are removed all the parts are tightly braced together, and the fossa poplitea is represented merely by a small intermuscular interval between the distal parts of the hamstring muscles. The fossa in this condition is rather under an inch wide at its broadest part. The popliteal artery, therefore, as it traverses the space, is covered by muscles throughout its whole course, with the exception of a very small part immediately proximal to the knee joint.

Nervus Cutaneus Femoris Posterior (O.T. **Small Sciatic**).—The posterior cutaneous nerve of the thigh enters the popliteal fossa at its proximal angle, and passes distally, immediately subjacent to the deep fascia. It gives one or two twigs through the fascia to the skin, and finally pierces the fascia in the distal part of the fossa. Its terminal twigs are distributed to the skin over the proximal part of the calf of the leg.

Nervus Tibialis (O.T. Internal Popliteal Nerve).—The tibial nerve enters the fossa at its proximal angle, emerging from under cover of the biceps femoris. It runs vertically downwards to the distal angle and thus bisects the fossa longitudinally. It commences about the middle of the thigh as the larger of the two terminal branches of the sciatic nerve, and it leaves the fossa at the lower border of the popliteus muscle, and enters the posterior region of the leg. Its superficial position in the fossa has already been referred to. When it enters the fossa it lies on the lateral side of the popliteal vessels, at the mid-length of the space it crosses superficial to them, and in the distal part of the space it is medial to them; consequently the muscular branches given off, in the lower part of the fossa, to the lateral head of the gastrocnemius, the plantaris, the soleus, and the popliteus pass posterior to the vessels on their way to the muscles they supply.

The branches of the nerve in the popliteal fossa are classified as cutaneous, muscular, and articular.

The *medial cutaneous nerve of the calf* is the cutaneous branch. It arises about the middle of the fossa, and proceeds distally in the furrow between the two heads of the gastrocnemius. It will afterwards be seen to unite with the peroneal anastomotic nerve, a little distal to the middle of the calf of the leg, to form the nervus suralis (Fig. 127).

The *muscular branches* supply both heads of the gastrocnemius, the plantaris, the soleus, and the popliteus: they come off in the distal part of the fossa. The branch to the popliteus requires special notice. It arises more distally than the others, and crosses the superficial surface of the popliteal artery to reach the lateral side of that vessel. It then runs distally on the posterior surface of the popliteus muscle, and gains the anterior surface by winding round the distal border. This will be better seen when the popliteus muscle is dissected.

The *articular branches* are three in number. They are given off by the tibial nerve in the proximal part of the fossa, sometimes even proximal to the fossa, and they accompany the middle genicular artery and the two medial genicular

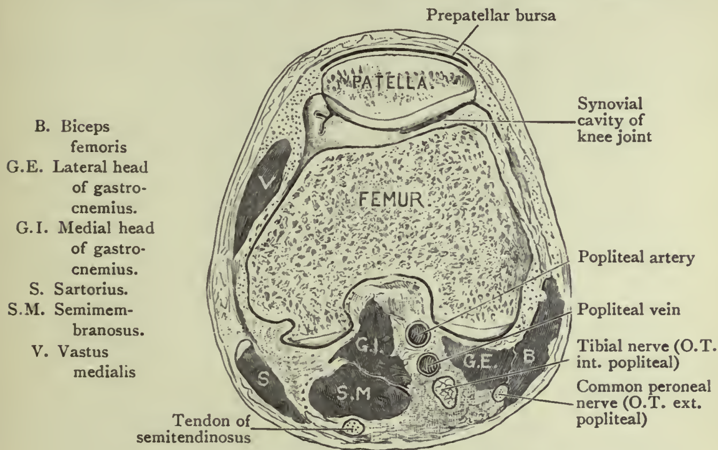


FIG. 133.—Transverse section through the Popliteal Fossa of the Right Inferior Extremity.

arteries. That which accompanies the inferior medial artery is larger than the other two, and can, as a rule, be easily discovered as it runs along the proximal border of the popliteus muscle.

Nervus Peronæus Communis (O.T. **External Popliteal**).—The common peroneal nerve is the smaller of the two terminal branches of the sciatic nerve. It arises, from the sciatic nerve, about the middle of the length of the thigh, and it terminates at the lateral side of the neck of the fibula, under cover of the peroneus longus, by dividing into a superficial and a deep peroneal terminal branch. It does not traverse the entire length of the popliteal fossa, for, as it runs distally and laterally along the medial border of the biceps femoris, it leaves the fossa at its lateral angle, where it crosses the plantaris and the lateral head of the gastrocnemius; then it passes behind the head of the fibula, from which it is

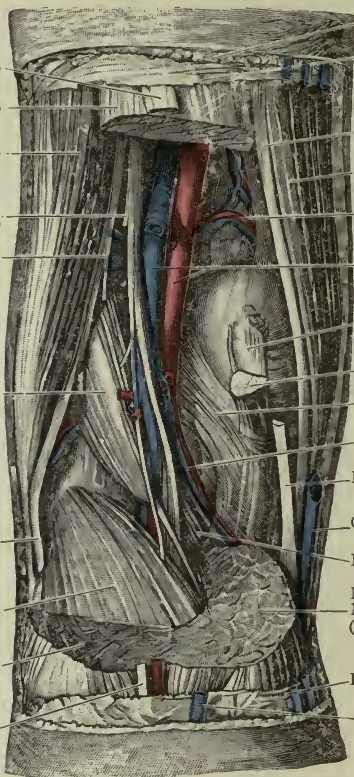


FIG. 134.—Popliteal Fossa. The two heads of the gastrocnemius and portions of the semimembranosus and semitendinosus have been removed so as to display more fully the contents of the fossa.

separated by the upper part of the soleus; finally it turns forwards, to its termination, between the lateral side of the neck of the fibula and the proximal part of the origin of the peroneus longus. It gives off two cutaneous and three articular branches.

The *cutaneous branches* are two in number, viz., the anasto-

PLATE XXI

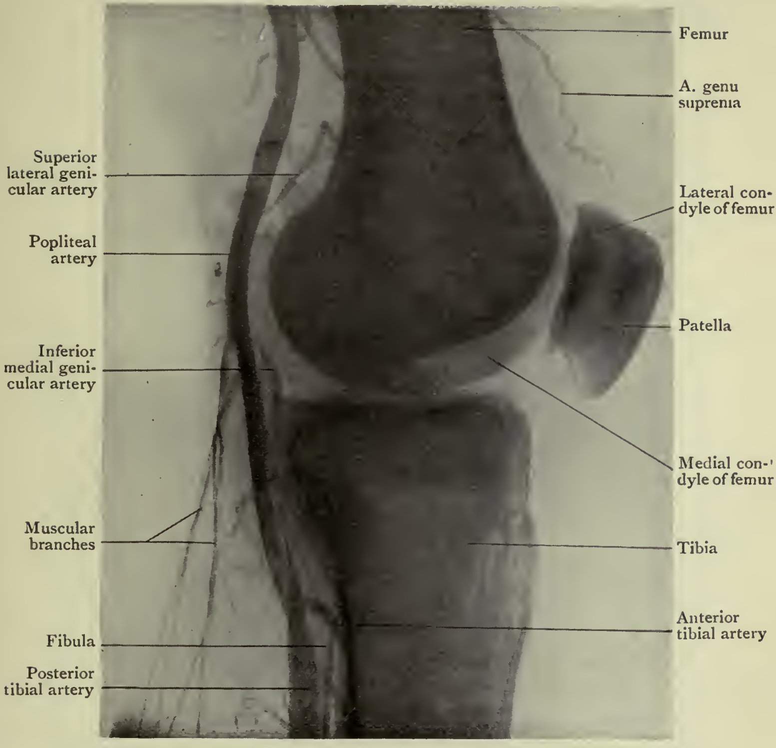


FIG. 135.—Radiograph of the Knee Region of an injected inferior extremity. (Major T. Rankine.)

PLATE XXII

FIG. 136.—Radiograph of the Knee Region of an injected inferior extremity. (Major T. Rankine.)

motic peroneal nerve, and the lateral cutaneous nerve of the calf, which supplies the skin on the anterior and lateral aspect of the proximal part of the leg. They frequently take origin by a common stem. The *anastomotic peroneal nerve* arises from the common peroneal trunk in the popliteal fossa, and is continued distally over the lateral head of the gastrocnemius. It ultimately unites with the medial cutaneous nerve of the calf to form the nervus suralis.

The *articular branches* are three in number. They are the superior and inferior lateral articular branches and the recurrent articular nerve. The first two accompany the superior and inferior lateral genicular branches of the popliteal artery respectively. They are of small size and are difficult to find. The *recurrent articular nerve* which springs from the termination of the common peroneal nerve will be dissected at a later stage (p. 356).

Arteria Poplitea.—The popliteal artery is the continuation of the femoral artery, and is therefore part of the great arterial trunk of the lower limb. It begins at the opening in the adductor magnus, where the femoral artery ends; and it terminates at the distal border of the popliteus muscle by dividing into the anterior and posterior tibial arteries. The division is hidden from view, at the present stage of the dissection, by the proximal border of the soleus muscle, but it will be exposed when the leg is dissected.

The course which the popliteal artery takes through the popliteal fossa is not straight. At first it descends vertically and so reaches the middle of the fossa between the condyles of the femur. From that point to its termination it inclines obliquely, distally and laterally. Throughout the greater part of its length it is placed deeply. In the proximal part of the fossa it is covered by the semimembranosus, but where it lies in the interval between the two condyles, although it is placed deeply in the fat of the fossa, it is covered merely by the integuments and fasciæ of the tibial nerve, and the popliteal vein. That part of the vessel is very short, however,—not more than about 25 mm.; then it passes between and anterior to the two heads of the gastrocnemius, is crossed by the plantaris, and finally, at its termination, it sinks under cover of the proximal border of the soleus. Throughout its whole course the popliteal artery rests against the floor of the popliteal fossa. In its proximal part it is separated from the femur by some fatty tissue; at the level of the interval between the condyles of the femur it crosses the oblique ligament of the knee joint; and, in the distal part of the fossa, it is in contact with the fascia covering the popliteus muscle.

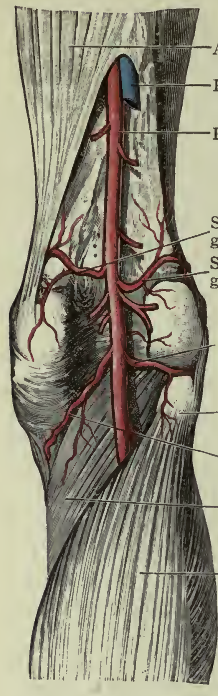


FIG. 137.—Right Popliteal Artery and its Branches.

The *popliteal vein* lies in a more superficial plane, and crosses the artery. In the proximal part of the fossa it is placed upon the lateral side of the artery, whilst in the distal part it is situated upon its medial side. The two vessels, however, are in close association throughout, and are bound together by a dense fibrous sheath.

The *tibial nerve* is superficial to both vessels, and crosses both from the lateral to the medial side; in the proximal part of the fossa it lies lateral to the vein, but in the distal part it lies on the medial side. Figs. 132, 133, 134.

The *branches of the popliteal artery* are:—

1. Muscular.
2. Cutaneous.
3. Genicular.

The *muscular branches* consist of a proximal and a distal set. The *proximal branches* are distributed to the hamstring muscles near their insertions. The *distal branches*, termed the *sural arteries*, end chiefly in the two heads of the gastrocnemius; but twigs go also to the soleus and plantaris.

The *cutaneous branch*, called the *superficial sural*, frequently arises from one of the sural muscular branches, and supplies the integument over the proximal part of the calf of the leg. It lies in the groove between the two heads of the gastrocnemius, with the medial cutaneous nerve of the calf.

The *genicular arteries* are five in number, viz., two superior, two inferior, and one middle or azygos.

Arteriæ Genu Superiores (Superior Articular Arteries).—The two superior genicular arteries spring from the main trunk in the interval between the condyles of the femur. One proceeds from each side of the popliteal artery, and they are called *medial* and *lateral*, according to the direction which they take. They were found resting directly upon the popliteal surface of the femur, and will be observed to incline slightly upwards, and then to wind round the bone immediately proximal to the condyles. The lateral artery is the larger of the two. The student is apt to mistake a muscular branch for one or other of these vessels; but their close apposition to the femur should in all cases be sufficient to distinguish them.

The *superior lateral genicular artery* runs laterally under cover of the biceps femoris, and disappears from the popliteal fossa by piercing the lateral intermuscular septum and entering the substance of the vastus intermedius. The *superior medial genicular artery* proceeds medially under cover of the semimembranosus, and leaves the popliteal fossa by piercing the posterior intermuscular septum; then it passes forwards, under cover of the tendon of the adductor magnus, to reach the deep surface of the vastus medialis.

Arteriæ Genu Inferiores (Inferior Articular Arteries).—The two inferior genicular arteries arise from the popliteal as it lies against the distal part of the oblique popliteal ligament. The *lateral inferior genicular artery* takes a transverse course laterally, under cover of the plantaris and lateral head of the gastrocnemius, to gain a point on the lateral side of the knee, immediately proximal to the head of the fibula. It proceeds onwards under cover of the fibular collateral ligament of the knee joint. The *medial inferior genicular artery* takes an oblique course, distally and medially, under cover of the medial head of the gastrocnemius, and along the proximal border of the popliteus muscle, to gain the medial side of the tibia distal to the medial condyle. There it turns forwards under cover of the tibial collateral ligament of the knee.

Arteria Genu Media (O.T. Azygos Articular Artery).—The middle genicular artery springs from the popliteal as it lies upon the oblique popliteal ligament of the knee joint. It pierces that ligament to reach the cruciate ligaments and the synovial layer.

Vena Poplitea.—The popliteal vein is formed, near the distal border of the popliteus muscle, by the union of the venæ comites of the anterior and posterior tibial arteries. It runs proximally through the popliteal fossa, and, entering the adductor canal, through the opening in the adductor magnus, it becomes the femoral vein. The relations which it presents to the popliteal artery have already been detailed. In addition to tributaries corresponding to branches of the artery, it receives the small saphenous vein, which has been seen piercing the popliteal fascia to join it. By slitting it open with the scissors the dissector will see that it possesses three (sometimes four) valves in its interior.

The *Genicular Branch of the Obturator Nerve.*—This slender continuation of the posterior division of the obturator nerve usually lies upon the posterior aspect of the popliteal artery. It enters the popliteal fossa by piercing the distal fibres of the adductor magnus; and it enters the knee joint after passing through the oblique popliteal ligament.

BACK OF THE THIGH.

The dissection of the back of the thigh must be completed on the fifth day. The following are the structures which are to be displayed :—

1. Superficial fascia.
2. Cutaneous nerves.
3. Deep fascia.
4. Muscles, { Biceps femoris. Semitendinosus. Semimembranosus. Adductor magnus.
5. Nerves, { Posterior cutaneous of thigh. Sciatic.
6. Arteries, Four perforating.

Dissection.—Reflection of Skin.—A vertical incision must be made, in the median line of the thigh, through the belt of skin which still encircles the limb posteriorly. The two flaps can then be reflected, the one laterally, and the other medially.

Superficial Fascia—Cutaneous Nerves.—The superficial fascia of the back of the thigh presents no features of special interest, but in it there ramify cutaneous nerves derived from four sources, (1) from the *posterior cutaneous nerve of the thigh*, (2) from the *lateral cutaneous nerve of the thigh*, (3) from the *posterior branch of the medial cutaneous nerve*, and (4) from the *obturator nerve*.

Dissection.—The branches of the posterior cutaneous nerve of the thigh must be sought in the superficial fascia along the middle of the back of thigh; they vary in number, and they pierce the deep fascia at varying levels (Fig. 127). The search for them will be facilitated if the dissector pulls gently on the trunk of the nerve where it is already exposed in the lower part of the gluteal region. The branches of the lateral and medial cutaneous nerves should be followed from the portions of those nerves which were displayed when the front and medial sides of the thigh were dissected (pp. 227, 248). No time need be lost in seeking for the cutaneous branch of the obturator nerve, for it is not only very variable in size and position, but also it is not uncommonly absent. When present it lies usually in the distal and medial part of the posterior area of the thigh.

When the cutaneous nerves of the back of the thigh have been studied the remains of the superficial fascia must be removed to display the deep fascia.

Deep Fascia.—The deep fascia of the back of the thigh is thin but fairly strong. It consists of longitudinal fibres blended with transverse fibres which serve to bind the hamstring muscles together.

Dissection.—Divide the deep fascia by a longitudinal incision running along the middle of the back of the thigh, and be careful not to injure the posterior cutaneous nerve of the thigh, which lies immediately under cover of the fascia. Turn the two flaps of deep fascia aside, and then follow and clean the posterior cutaneous nerve which is now exposed in the whole of its length.

After the trunk of the posterior cutaneous nerve of the thigh has been secured clean the posterior surfaces of the hamstring muscles. They are three in number, the biceps femoris, the semitendinosus, and the semimembranosus. The long head of the biceps springs from the posterior part of the tuberosity of the ischium, by means of a tendon common to it and the semitendinosus. It is recognised by the fact that it runs distally and laterally, whilst the semitendinosus and semimembranosus run distally and medially. The short head arises from the body of the femur. Pull the long head of the biceps medially to expose the sciatic nerve, which lies deep (anterior) to it; then follow the lateral border of the sciatic nerve to secure the branch which goes from it to the short head of the biceps. Next pull the sciatic nerve laterally and clean the branches which pass from it to the long head of the biceps, the semitendinosus, the semimembranosus, and the adductor magnus. As a rule there is one branch to the long head of the biceps, a branch which divides to supply the semimembranosus and the adductor magnus,

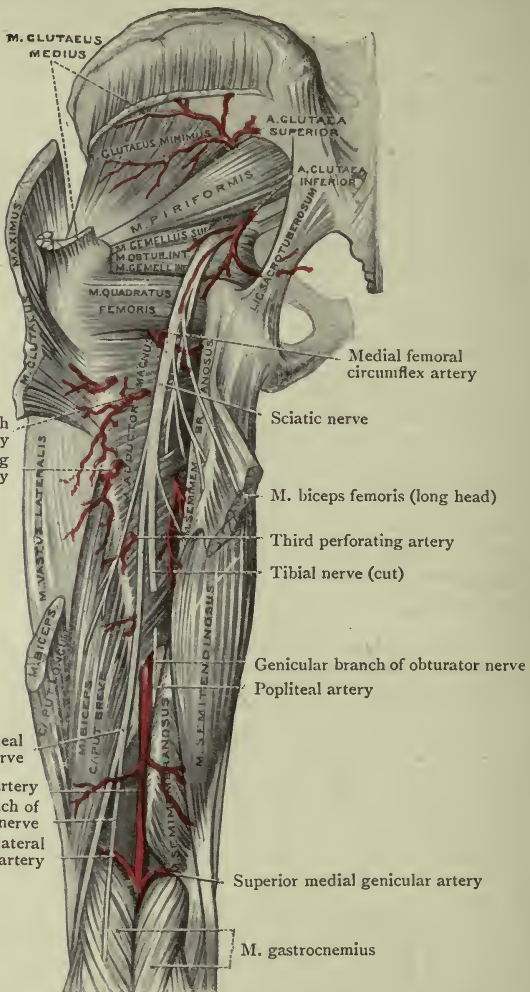


FIG. 138.—Dissection of the Posterior Region of the Thigh.

and there are two branches to the semitendinosus, an upper and a lower. The lower branch to the semitendinosus will be found about the middle of the thigh; the other branches arise about the level of the ischial tuberosity.

As the nerves to the muscles are being followed; arteries will be found piercing the adductor magnus and passing into the hamstring muscles; they are branches of the profunda artery. As many of them as possible should be preserved and cleaned. After the nerves and arteries have been secured, pull the long head of the biceps and the semitendinosus laterally, and clean the semimembranosus, which lies on a deeper plane.

M. Biceps Femoris.—The biceps femoris arises by two heads—a *long* or *ischial*, and a *short* or *femoral*,—and is inserted, chiefly, into the head of the fibula. The *long head* arises from the ischium by a tendon, common to it and the semitendinosus (Fig. 128, p. 286), which is implanted into the medial of the two impressions on the upper part of the ischial tuberosity. Some fibres from the sacro-tuberous ligament are continued into it. The *short head* arises from the back of the femur, distal to the insertion of the glutæus maximus, viz., from the lateral lip of the linea aspera, from the proximal half of the lateral supracondylar ridge, and from the lateral intermuscular septum. Its parallel fibres run obliquely distally and laterally, and join the anterior and medial surface of the tendon of insertion. This tendon, on the lateral aspect of the knee joint, is split into an anterior and a posterior part by the fibular collateral ligament. Both parts are inserted into the upper aspect of the head of the fibula anterior to the apex capituli, but, in addition, the posterior part sends an aponeurotic expansion to the deep fascia of the leg, and by means of a similar expansion the anterior part gains attachment to the lateral condyle of the tibia. Each head of the biceps femoris receives its nerve supply from the sciatic nerve. The twigs to the long head are derived from the tibial part of the sciatic nerve, and that to the short head from the common peroneal part. Both heads flex the knee joint and rotate the leg laterally. The long head is also an extensor of the hip joint.

M. Semitendinosus.—The semitendinosus muscle arises from the medial impression on the superior part of the tuberosity of the ischium by a tendon common to it and the long head of the biceps femoris (Fig. 128, p. 286). The muscular belly ends, in the distal third of the thigh, in a long cylindrical tendon which passes downwards on the semimembranosus muscle. At the medial side of the knee the tendon bends forwards, crosses the tibial collateral ligament of the knee joint, and, becoming flattened, is inserted into the proximal part of the medial surface of the body of the tibia, near the anterior crest of that bone, and immediately distal to the tendon of the gracilis. From its distal border aponeurotic fibres pass into the deep fascia of the leg; its proximal border is adherent to the gracilis for about half an inch from its insertion, and both tendons are concealed by the expanded insertion of the sartorius. A mucous bursa lies between the three tendons and the tibial collateral ligament of the knee joint.

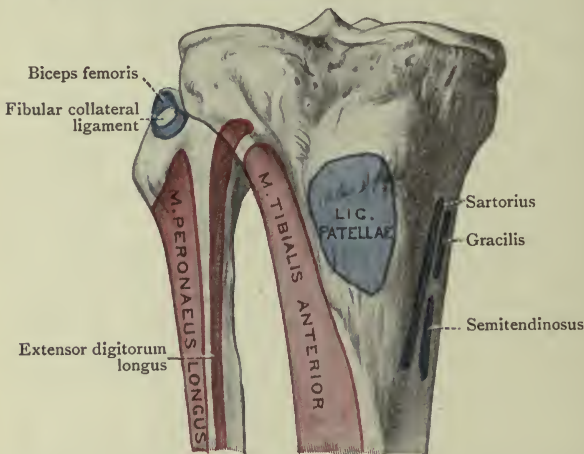


FIG. 139.—Anterior aspect of Proximal Portions of Bones of Leg with Attachments of Muscles mapped out.

The muscular belly of the semitendinosus is divided into proximal and distal parts by a very oblique tendinous intersection, and each part receives a branch from the sciatic nerve. The muscle is a flexor of the knee, a medial rotator of the leg, and an extensor of the hip joint.

M. Semimembranosus.—The semimembranosus muscle arises from the lateral impression on the upper part of the tuberosity of the ischium (Fig. 128, p. 286). The tendon of origin is broad at its attachment to the bone, and narrows as it passes medially anterior to the origin of the biceps femoris; it then expands again, and, passing distally and medially, anterior to the semitendinosus, is folded in such a manner as to form a groove, in which the semitendinosus lies. The tendon of insertion is attached chiefly to the floor of the groove on the back of the medial condyle of the tibia, under cover of the tibial collateral ligament of the knee joint. Three additional attachments, however, must be noted. These are effected by aponeurotic extensions from the tendon of insertion—(1) to the back of the capsule of the knee joint, forming a considerable part of the oblique popliteal ligament; (2) to the surface of the popliteus muscle, which is covered by the expansion; and (3) to the tibial collateral ligament of the knee joint. The semimembranosus is supplied by the sciatic nerve. Its actions are the same as those of the semitendinosus (see p. 322).

Nervus Ischiadicus (O.T. **Great Sciatic Nerve**).—The sciatic nerve commences at the lower border of the greater sciatic foramen, and usually terminates about the middle of the thigh, but occasionally at a higher level, by dividing into the tibial nerve and common peroneal nerve. Its relations in the gluteal region have already been studied. In the thigh it lies on the posterior surface of the adductor magnus muscle, and is covered by the long head of the biceps femoris. It gives branches to both heads of the biceps, to the semitendinosus, to the semimembranosus, and to the adductor magnus; the branches to the two last-named muscles arise by a common trunk. In a few cases it gives off a long articular twig, which enters the popliteal fossa and takes the place of the lateral superior articular nerve, which, as a rule, is a branch of the common peroneal nerve.

Dissection.—To bring the adductor magnus more fully into view, and to facilitate the cleaning of its posterior surface, and at the same time to follow the terminal parts of the perforating arteries, the hamstring muscles should be detached from their origins and thrown distally. First detach the common tendon of the biceps femoris and semitendinosus from the ischial tuberosity. When that has been done the exact attachment of the semimembranosus is displayed, and after that muscle has been again examined, under the present more advantageous circumstances, it also must be detached from its origin and turned distally. The posterior surface of the adductor magnus will then be fully exposed, and its attachment to the femur and its relations to the perforating arteries can be studied.

Arteriæ Perforantes.—Four perforating arteries will be found in the posterior part of the thigh between the adductor magnus muscle and the femur, close to the linea aspera.

They are branches of the profunda femoris and are called *first*, *second*, *third*, and *fourth*, according to the level at which they appear, proximo-distally. The *fourth* is the terminal branch of the profunda, it makes its appearance about 25 mm. (one inch) proximal to the opening in the adductor magnus muscle through which the popliteal artery enters the popliteal fossa. The perforating arteries and their branches must be thoroughly cleaned, together with the apertures in the adductor magnus through which they pass. It will then be seen that they do not pierce the fleshy substance of the muscle, for behind each is a tendinous arch, and the arteries reach the posterior region of the thigh by passing between the arches and the linea aspera, to which the piers of the arches are attached.

The openings are in the same line with and are in all respects analogous to the large opening in the adductor magnus muscle for the popliteal artery. The result obtained is the same in each case; when the muscle contracts, the vessels are protected from pressure.

After passing the tendinous arches the perforating arteries wind round the posterior border of the femur on their way to the vastus lateralis muscle, in which they end, and in which they anastomose with branches of the lateral femoral circumflex artery. The highest perforating artery pierces the insertion of the glutæus maximus before it reaches the vastus lateralis, and the lower three pierce the femoral head of the biceps femoris and the lateral intermuscular septum.

Anastomoses on the Posterior Aspect of the Thigh.—In a well-injected subject a chain of arterial anastomoses can be traced from the gluteal region to the popliteal fossa, and the present is the best time to examine it. Commencing proximally, in the gluteal region, the superior gluteal artery is found anastomosing with the inferior gluteal, and the inferior gluteal with the terminal branches of the medial femoral circumflex artery. In the posterior part of the thigh the chain of anastomoses is carried distally by the medial and lateral femoral circumflex arteries anastomosing with the first perforating artery, and by anastomoses between the perforating arteries. The chain is completed distally by anastomoses between the most distal perforating arteries and the muscular branches given from the popliteal artery to the hamstring muscles.

Dissection.—**At the end of the fifth day after the subject has been placed upon its face, the dissector must paint the various parts in the gluteal and thigh regions with the preservative solution, replace them in position, and fix the skin flaps over them with a few points of suture. On the morning of the following day he will find the body replaced upon its back, with the pelvis and thorax supported by blocks, and he must at once proceed to study any part of the medial region of the thigh previously left undissected, and to examine the hip joint.**

Articulatio Coxæ (Hip Joint).—The hip joint is the most perfect example of an enarthrosis or ball-and-socket joint in the body. It does not allow so free a range of movement as that which takes place at the shoulder joint, but what it loses in this respect it gains in strength and stability. Its great strength and security depend—(1) upon the depth of the acetabulum and the thorough manner in which the head of the femur is received into it; (2) upon the tension and power of the ligaments; (3) upon the length and oblique direction of the neck of the femur; (4) upon atmospheric pressure and upon the strength of the surrounding muscles.

The *ligaments* in connection with the hip joint are:—

1. Capsula articularis.
    - Lig. ilio-femorale.
    - Lig. ischio-capsulare.
    - Lig. pubo-capsulare.
2. Ligamentum teres.
3. Labrum glenoidale.
4. Lig. transversum acetabuli.

The capsule and the ligamentum teres are attached to both bones entering into the construction of the joint. The transverse ligament and the labrum glenoidale are connected with the hip bone only; the former partially fills the acetabular notch, whilst the latter surrounds the circumference of the acetabulum in a ring-like fashion, and serves to deepen it still further.

Capsula Articularis.—The fibrous stratum of the articular capsule is exceedingly strong, and surrounds the joint on all sides. *Proximally*, it is attached around the acetabulum; above and posteriorly, directly to the hip bone, just beyond the rim of the cavity; anteriorly, to the superficial aspect of the labrum glenoidale; and below, to the transverse ligament. *Distally*, it clasps the neck of the femur; anteriorly, it is attached to the whole length of the intertrochanteric line, and to the root of the greater trochanter; this attachment is very firm and strong; posteriorly, it falls short of the intertrochanteric crest by about half an inch, and its attachment to the distal part of the posterior surface of the neck of the femur is weak.

When the capsule of the hip joint has been carefully cleaned it will be seen that the fibres which compose it run in two different directions. The majority pass longitudinally from the hip bone to the femur. There are, however, other fibres which lie more or less at right angles to the longitudinal fibres. They constitute the *zona orbicularis* and are seen to

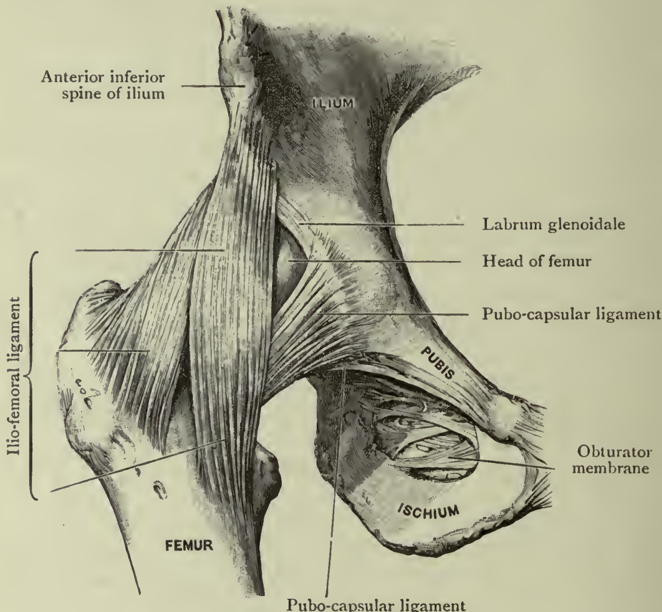


FIG. 140.—Dissection of Hip Joint from the front.

advantage only on the posterior aspect of the capsule, where they were noted during the dissection of the gluteal region (p. 304). The longitudinal fibres are most massed on the front of the joint.

Certain thickened portions of the capsule, with more or less distinct attachments, are described under special names. They are :—

1. Ilio-femoral ligament.
2. Pubo-capsular ligament.
3. Ischio-capsular ligament.
4. The zona orbicularis.

Ligamentum Ilio-femorale.—The ilio-femoral ligament is placed over the front of the articulation, and constitutes the thickest and most powerful part of the capsule. Proximally it is attached to the anterior inferior spine of the ilium and to the depressed surface immediately lateral to that spine.

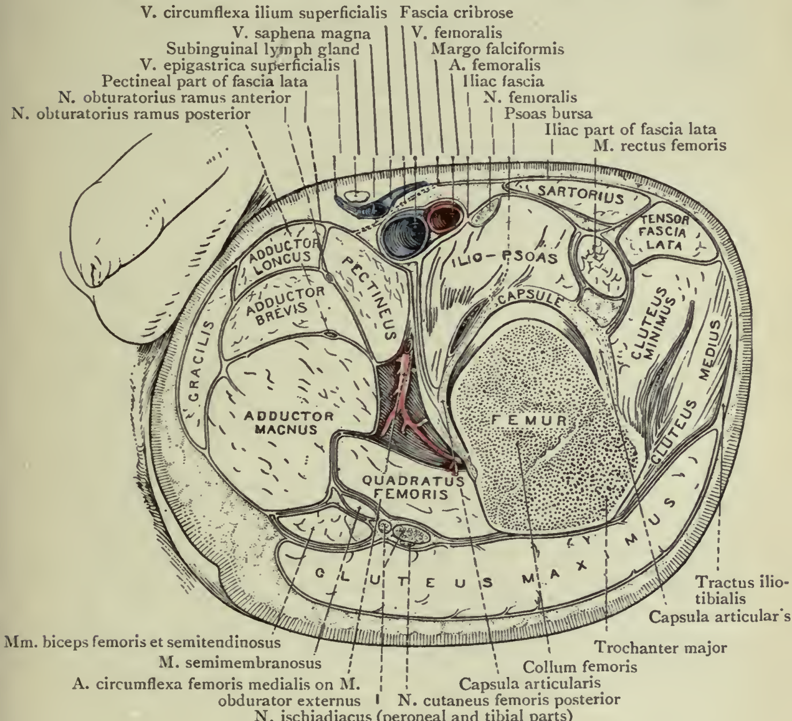


FIG. 141.—Dissection of an oblique transverse Section through upper part of Thigh showing the relation of the Fascia to the Muscles.

Distally it is attached to the intertrochanteric line of the femur. At its upper or iliac end it is a single mass of fibres, but as it passes distally, it divides into a *lateral* and a *medial* band (Fig. 140).

The lateral and shorter band is implanted into the upper part of the intertrochanteric line and to the adjacent part of the greater trochanter. It is sometimes called the *ilio-*

trochanteric band. The more medial and longer band is almost vertical, and its distal end is attached to the lower part of the intertrochanteric line. The interval between the two diverging bands is occupied by a thinner portion of the capsule which is perforated by an articular twig from the ascending branch of the lateral femoral circumflex artery. The ilio-femoral ligament is sometimes called the Y-*shaped ligament*, but, in making use of this term, remember that the shape it presents is that of an inverted Y.

Ligamentum Pubocapsulare (O.T. *Pubo-femoral Ligament*).—The pubo-capsular ligament is the name applied to fasciculi which spring from the pubic bone and the obturator membrane, and join the lower and anterior aspect of the capsule. In cases where the bursa under the ilio-psoas is continuous with the cavity of the joint, the aperture of communication is placed between this band and the ilio-femoral ligament.

Ligamentum Ischiocapsulare (O.T. *Ischio-femoral Ligament*).—The ischio-capsular ligament is a comparatively weak band which springs from the ischium, below the acetabulum, and passes upwards and laterally, anterior to the tendon of the obturator externus. It terminates in the capsule.

Zona Orbicularis (O.T. *Orbicular Ligament*).—The zona orbicularis is composed of circular fibres, which are most distinct on the posterior aspect of the capsule. It encircles the neck of the femur posteriorly and below, but is lost as it is traced anteriorly towards the upper and anterior parts of the capsule.

The dissector has already noted the close connection which is exhibited between the capsule of the hip joint and the tendons of the glutæus minimus, and the reflected head of the rectus femoris. Reinforcing fibres are contributed to the capsule by both of those tendons.

Movements permitted at the Hip Joint.—Before the capsule of the joint is opened the range of movement which is permitted at the hip joint should be tested. *Flexion*, or forward movement, is very free, and is checked by the anterior surface of the thigh coming into contact with the abdominal wall. *Extension*, or backward movement, is limited by the ilio-femoral ligament. That powerful ligament has a most important part to play in preserving the upright attitude with the least possible expenditure of muscular exertion. In the erect posture the line of gravity falls slightly behind the line joining the central points of the two hip joints. In the upright attitude the ilio-femoral ligaments are tense, and prevent the pelvis from rolling backwards on the heads of the femora. *Abduction*, or lateral movement of the limb, is checked by the pubo-capsular ligament. *Adduction*, or medial movement (*e.g.* as in crossing one thigh over the other), is limited by the proximal portion of the ilio-femoral ligament and the upper part of the capsule. *Rotation medially* tightens the ischio-capsular ligament, and is therefore, in a measure, restrained by it. *Rotation laterally* is limited by the lateral portion of the ilio-femoral ligament. In *circumduction*, which is produced by combination of the movements of flexion, abduction, extension, and adduction, different parts of the capsular ligament are tightened at different stages of the movement.

The *flexor muscles* of the hip joint are chiefly—(1) the ilio-psoas, (2) the rectus femoris, (3) the pectineus, (4) the adductors longus and brevis and the pubic fibres of the adductor magnus; the *extensors* are—(1) the glutæus maximus, (2) the hamstrings, (3) the ischial fibres of the adductor magnus, (4) the posterior fibres of the glutæus medius, (5) the posterior fibres of the glutæus minimus; the *adductor muscles* are—(1) the three adductors, (2) the gracilis, (3) the pectineus, (4) the obturator externus, (5) the lowest fibres of the glutæus maximus, (6) the quadratus femoris; the *abductors* are—(1) the upper part of the glutæus maximus, (2) the tensor fasciæ latæ, (3) the glutæus medius, (4) the glutæus minimus.

The *medial rotators* are—(1) the ilio-psoas, (2) the anterior part of the glutæus medius, (3) the anterior part of the glutæus minimus, (4) the tensor fasciæ latæ; the *lateral rotators* are—(1) the two obturator muscles, (2) the gemelli, (3) the piriformis, (4) the quadratus femoris, (5) the three adductors, (6) the pectineus, (7) the inferior fibres of the glutæus maximus, (8) the ilio-psoas.

It must be noted that the obturator muscles, the piriformis, and the gemelli, which act as lateral rotators when the body is erect, become abductors when the joint is flexed, and that the ilio-psoas is a flexor of the hip joint and a medial rotator of the thigh until flexion is almost complete, then it becomes a lateral rotator.

Dissection.—**The hip joint should now be opened. Make one incision along the upper border and another along the medial border of the ilio-femoral ligament in order to isolate that band from the rest of the capsule, then remove all other parts of the capsule. The object of this dissection is to enable the dissector to appreciate the great strength of the ilio-femoral ligament. It is fully a quarter of an inch thick, and a strain varying from 250 lbs. to 750 lbs. is required for its rupture (Bigelow). It is very rarely torn asunder in dislocations, and consequently the surgeon is enabled in most cases to reduce the displacement by manipulation. The ilio-femoral ligament may now be removed.**

Labrum Glenoidale (O.T. Cotyloid Ligament).—The labrum glenoidale is a firm fibro-cartilaginous ring, which is fixed to the brim or margin of the acetabulum; it bridges across the notch, in the lower margin of the acetabulum, and thus completes the circumference of the cavity, deepens it, and at the same time narrows its mouth to a slight extent. The labrum glenoidale fits closely upon the head of the femur, and, acting like a sucker, exercises an important influence in retaining it in place. Both surfaces of the labrum are covered with synovial membrane; its free margin is thin, but it is much thicker at its attachment to the acetabular brim.

Ligamentum Transversum Acetabuli.—The transverse ligament consists of transverse fibres which bridge across the acetabular notch, and are attached to its margins. It lies between the labrum glenoidale laterally and the bottom of the notch medially, but a space is left between the medial

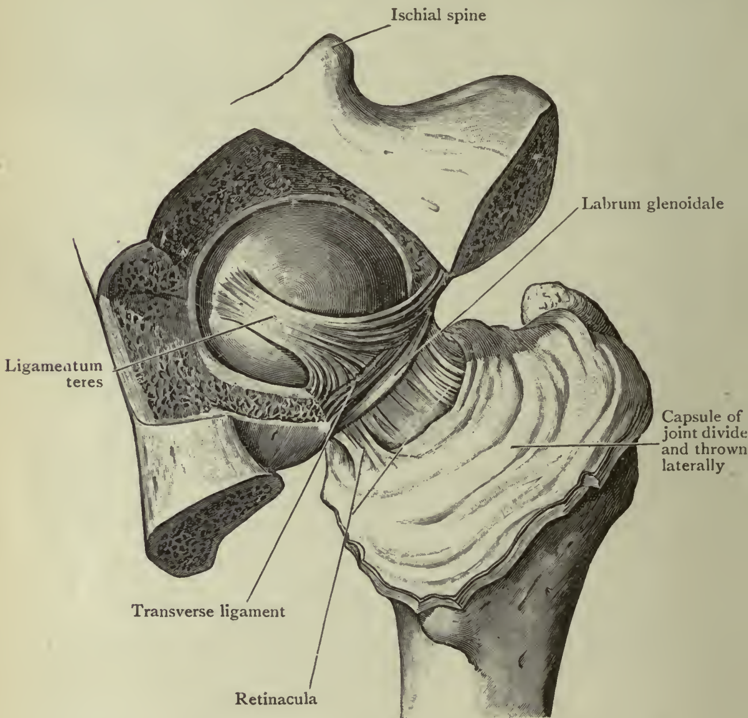


FIG. 142.—Dissection of Hip Joint from behind. The bottom of the acetabulum has been removed to show the ligamentum teres.

margin of the ligament and the bottom of the incisura through which vessels and nerves enter the joint. The lateral margin of the ligament is attached to the labrum glenoidale.

Ligamentum Teres Femoris.—The ligamentum teres is not round, as its name might lead one to expect, but is somewhat flattened and fan-like in shape. Its narrow

PLATE XXIII

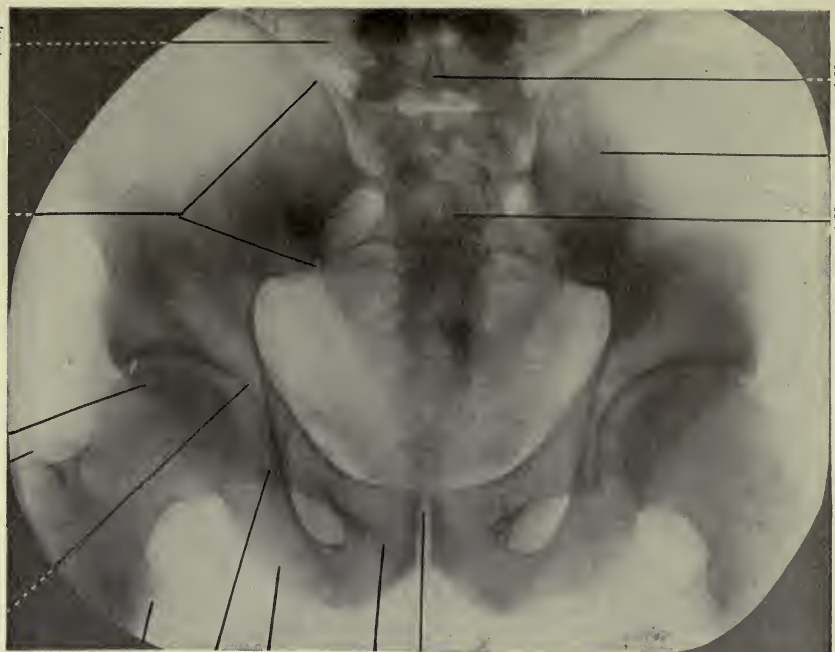


FIG. 143.—Radiograph or the Pelvis of an adult.

(Dr. R. Knox.)

PLATE XXIV

FIG. 144.—Radiograph of the Hip Joint of an adult.
(Dr. R. Knox.)

PLATE XXV

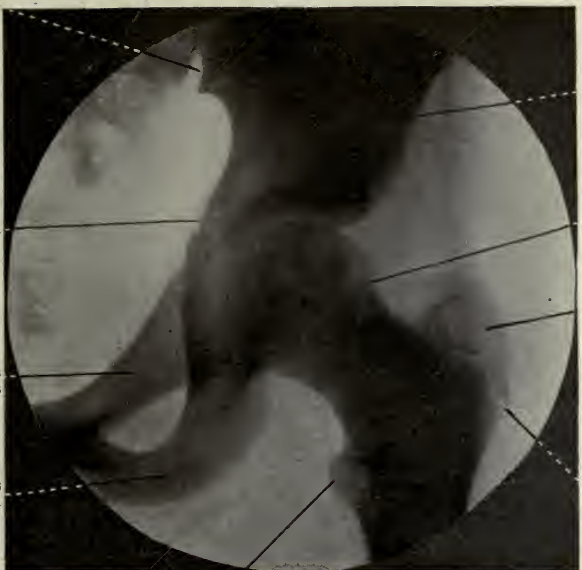


FIG. 145.—Radiograph of the Hip Region of a child.

The rami of the pubis and ischium have fused. The epiphyseal line of the lesser trochanter is visible.

PLATE XXVI

FIG. 146.—Radiograph of the Hip Region of a child 11 years old.

The epiphysis of the lesser trochanter has not yet appeared. The inferior rami of the pubis and ischium have fused.

PLATE XXVII

FIG. 147.—Radiograph of the Hip Region of a child.

The epiphysis of the lesser trochanter has not yet appeared, but the inferior rami of the pubis and ischium have fused.

PLATE XXVIII

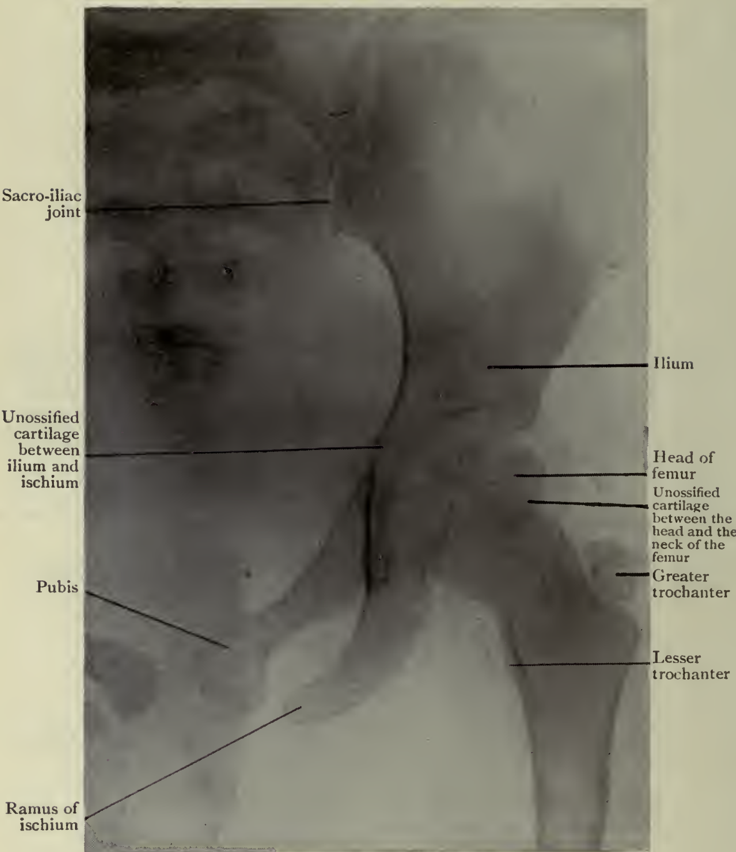


FIG. 148.—Radiograph of the Hip Region of a child.
The epiphysis of the lesser trochanter has not yet appeared, and the inferior rami of the pubis and ischium have not yet united.

PLATE XXIX

FIG. 149.—Radiograph of the Hip Region of a child.

The epiphysis of the greater trochanter has just appeared. The inferior rami of the pubis and ischium have not yet united.

PLATE XXX

FIG. 150.—Radiograph of the Hip Region of a child.

The gaps between the various segments of the bones indicate the sizes of the intervening cartilage segments.

femoral extremity is implanted into the fovea capitis femoris, whilst its flattened acetabular end is bifid, and is fixed to the margins of the acetabular notch, and also to the transverse ligament. This attachment can be defined by the removal of the synovial layer and some areolar tissue. The ligamentum teres is surrounded by a prolongation of the synovial layer, and a small artery runs along it to the head of the femur.

It is difficult to understand the part which the ligamentum teres plays in the mechanism of the hip joint. It presents very different degrees of strength in different subjects. It becomes very tense when the thigh is slightly flexed and then adducted.

The Interior of the Joint and the Synovial Stratum.—A mass of soft fat occupies the non-articular bottom of the acetabulum. Upon this the ligamentum teres is placed, and blood-vessels and nerves enter it by passing through the notch under cover of the transverse ligament. The vessels are derived from the medial femoral circumflex and the obturator arteries, and the nerves are twigs from the anterior branch of the obturator nerve, from the accessory obturator, when it is present, and from the nerve to the rectus femoris muscle. A nerve-twig is also supplied to the posterior part of the joint by the nerve to the quadratus femoris.

The *synovial stratum* lines the inner surface of the fibrous stratum of the capsule. From the fibrous stratum it is reflected on to the neck of the femur, and it clothes the bone as far as the margin of the articular cartilage which covers the head. Along the line of reflection some fibres of the fibrous stratum proceed proximally on the neck of the femur and raise the synovial layer in the form of ridges. These fibres are termed the *retinacula* or *cervical ligaments.*

The *retinacula* are of some surgical importance. In intracapsular fracture of the neck of the femur they may escape rupture, and they may then, to some extent, help to retain the fragments in apposition. Hence examinations of this class of fracture must be conducted gently, lest by rupturing this ligamentous connection the fragments be permanently displaced.

At the acetabular attachment of the capsule the synovial membrane is reflected on to the labrum glenoidale and invests both its surfaces. It also covers the articular surface of the transverse ligament and the cushion of fat which occupies the bottom of the cavity. Lastly, it gives a tubular investment to the ligamentum teres.

Removal of the Limb.—The limb must now be removed from the trunk by dividing the ligamentum teres. It should then be taken to one of the tables set aside for the dissection of separate parts. Before proceeding to the dissection of the leg the attachments of the various muscles to the femur should be revised. The bulk of the muscles may be removed, but a small portion of each should be left, so that the attachments may again be revised, should it be found necessary to do so, at a later period.

THE LEG.

Surface Anatomy.—Before the dissection of the leg is commenced, the relations of the tibia and fibula to the surface should be carefully investigated. The sharp *anterior crest* or *shin* of the tibia does not form a projection visible to the naked eye, but, nevertheless, it is subcutaneous and can be felt very distinctly when the finger is passed along it. It extends from the tuberosity of the tibia to the anterior border of the medial malleolus, pursuing a slightly sinuous course, and in its distal part it is rounded off and indistinct.

The broad flat medial surface of the body of the tibia is also subcutaneous, distal to the level of the insertion of the sartorius, and the medial border of the bone which forms its posterior boundary can be followed by the finger throughout its entire length from the medial condyle, to the posterior border of the medial malleolus. It indicates the position of the great saphenous vein and the saphenous nerve.

The fibula, on the whole, is more deeply placed. The head is easily distinguished below and posterior to the lateral condyle of the tibia; the trunk of the peroneal nerve lies behind it. The proximal half of the body of the bone is concealed by the surrounding muscles and cannot be palpated satisfactorily. The distal end of the bone, which forms the lateral malleolus, and the distal part of the body, proximal to the malleolus, are subcutaneous in a triangular area which will be found to be bounded anteriorly by the peronæus tertius, and by the peronæus longus and brevis muscles posteriorly.

The two malleoli form marked projections in the region of the ankle. The medial malleolus is the broader and more

PLATE XXXI

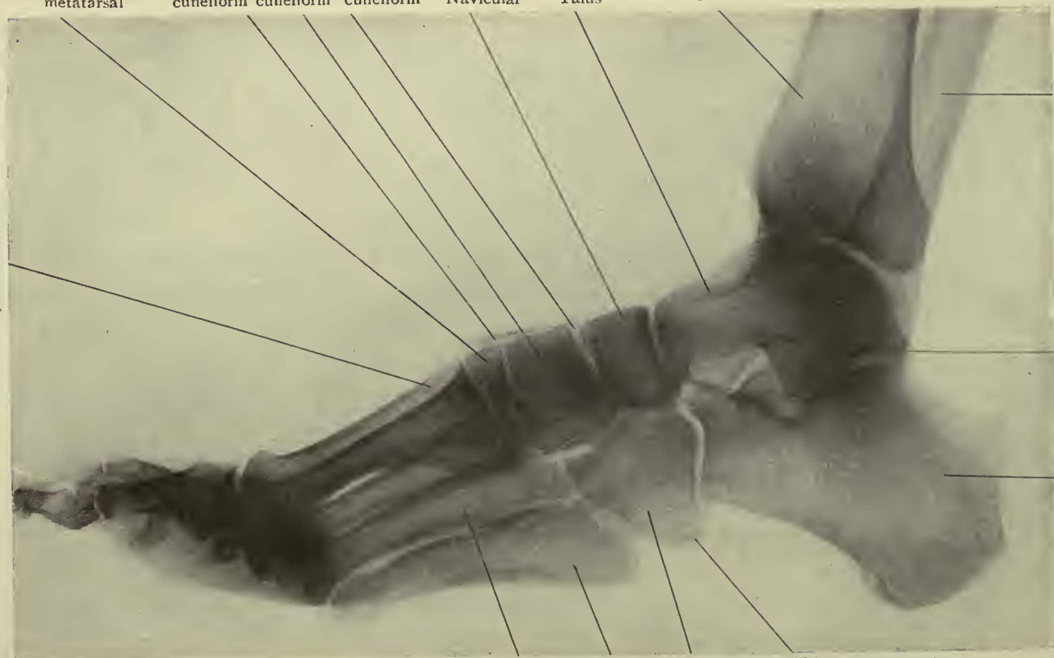


FIG. 151.—Radiograph of the Foot of an Adult.
(Major T. Rankine.)

prominent of the two; it does not pass so far distally, but its anterior border is situated more anteriorly than the lateral malleolus. This is due to its greater breadth; because, when examined from behind, the posterior borders of the two projections are seen to occupy very nearly the same transverse plane.

On the posterior aspect of the leg the prominence known as the "calf of the leg" is visible. This is largely due to the fleshy bellies of the gastrocnemius muscle. Distal to the calf, and immediately proximal to the heel, the powerful tendo calcaneus can be felt. Anterior to that tendon a slight hollow is apparent on each side of the limb.

The skin will be reflected from the dorsum of the foot during the dissection of the leg; therefore the present opportunity should be seized for studying the surface anatomy of the foot. The individual tarsal bones cannot be recognised through the integument which covers the dorsum of the foot; but if the foot is powerfully extended, the head of the talus will be brought into view, in the shape of a slight prominence, which lies below and anterior to the ankle joint. The margins of the foot require careful study, because it is by the recognition of certain bony projections in them that the surgeon is enabled to determine the point at which to enter the knife when he is called upon to perform partial amputation of the foot. Examine the *medial margin* first. Begin posteriorly, at the projection formed by the medial process of the calcaneus, and proceed forwards. About one inch below the medial malleolus the medial edge of the sustentaculum tali may be recognised, and about one inch, or a little more, anterior to that, is the tubercle of the navicular. Then comes the first cuneiform bone, which is succeeded by the first metatarsal bone. None of these bony points can be said to form visible prominences on the surface. In order to distinguish them the medial margin of the foot must be carefully palpated. On the *lateral margin* of the foot the tuberosity on the base of the fifth metatarsal bone stands out as a distinct landmark. Posterior to it is the cuboid, and still more posterior the lateral surface of the calcaneus, which is almost completely subcutaneous. When present in a well-developed form, the trochlear process (O.T. peroneal tubercle) on this surface may be distinguished, about one inch distal and a little anterior to the lateral malleolus. If the foot is strongly inverted the anterior end of the calcaneus will be seen to project on the surface.

Subdivision of the Leg into Regions.—In the dissection of the leg four distinct regions may be recognised, viz. :—

1. An *anterior crural region*, in which are placed those structures which lie anterior to the interosseous membrane, and between the two bones of the leg.
2. A *medial crural region*, corresponding to the subcutaneous or medial surface of the body of the tibia.
3. A *lateral crural region*, which includes the parts in relation to the lateral surface of the fibula.
4. A *posterior crural region*, in which are placed the parts, on the back of the leg, which lie posterior to the interosseous membrane and the two bones of the leg.

Anterior Crural Region and Dorsum of Foot.

The anterior crural region should be dissected first, and it is usual to conjoin with this the dissection of the dorsum of the foot. The following parts are exposed :—

1. Superficial veins.
2. Cutaneous nerves.
3. Deep fascia, with its inter-muscular septa, the transverse ligament of the leg, the lig. laciniatum, and the cruciate ligament of the leg.
4. Tibialis anterior.
5. Extensor digitorum longus.
6. Peronæus tertius.
7. Extensor hallucis longus.
8. Anterior tibial vessels.
9. Perforating branch of the peroneal artery.
10. Deep peroneal nerve.
11. Recurrent articular branch from the common peroneal nerve.
12. Extensor digitorum brevis.
13. Dorsalis pedis vessels.

Dissection.—**Reflection of Skin.**—To place the limb in a convenient position for the dissection of this region, a block should be introduced beneath the knee, and the foot should be extended and fastened firmly to the table by means of hooks. The skin should be reflected from the *tibial* and *peroneal* (*medial* and *lateral*) *crural* regions at the same time. *Incisions* :—(1) a vertical cut along the median line of the leg and dorsum of the foot to the base of the middle toe ; (2) a transverse incision across the ankle joint ; (3) a transverse incision across the dorsum of the foot at the roots of the toes.

The four flaps of skin, thus mapped out (10, 11, 12, 13, Fig. 104), must now be raised from the subjacent fatty tissue, and the superficial veins and nerves dissected out.

Superficial Fascia.—The superficial fascia of the front and the medial and lateral sides of the leg and the dorsum of the foot presents no peculiar features; and it contains as a rule only a moderate amount of fat, in which lie the cutaneous veins and nerves.

The veins which will be met with in it during the dissection are :—

1. The dorsal digital veins of the toes.
2. The dorsal venous arch.
3. The distal part of the great saphenous vein.
4. The distal part of the small saphenous vein.

The cutaneous nerves or their branches which should be secured as they pass through the superficial fascia are :—

1. N. cutaneus suræ lateralis.
2. N. suralis.
3. N. saphenus.
4. N. peronæus superficialis.
5. N. peronæus profundus.

Dissection.—The lateral cutaneous nerve of the calf was displayed in the dissection of the popliteal space, arising from the common peroneal nerve or in common with the peroneal anastomotic branch. Trace it now to its termination on the anterolateral aspect of the leg.

After the lateral cutaneous nerve of the calf has been traced to its termination, the cutaneous veins should be dissected, for, on the dorsum of the foot, they lie more superficially than the nerves, and in other situations they serve as guides to the positions of some of the nerves. Commence with the dorsal venous arch of the foot. It lies opposite the anterior parts of the bodies of the metatarsal bones and is usually visible, after the skin has been reflected, in at least part of its extent. Follow it medially to the medial border of the foot, where it joins with the medial dorsal digital vein of the great toe to form the commencement of the great saphenous vein. Next follow the great saphenous vein upwards, in front of the medial malleolus and obliquely across the medial surface of the distal third of the tibia to the medial border of the tibia. The remainder of the great saphenous vein will be displayed when the medial sural region is dissected, therefore do not follow it further at present, but secure the distal part of the saphenous nerve, which lies close to it, and follow the nerve to the middle of the medial border of the foot, where it ends. When the dissection of the saphenous nerve is completed follow the dorsal venous arch laterally to the lateral margin of the foot, where it unites with the lateral dorsal digital vein of the little toe to form the small saphenous vein. Follow the small saphenous vein backwards below the lateral malleolus and there secure the sural nerve, which lies adjacent to the vein. Follow the sural nerve forwards. About the middle of the lateral border of the foot it gives a twig of communication, to a branch of the lateral division of the superficial peroneal nerve, and then continues onwards to the lateral part of the dorsal aspect of the little toe. Follow it to its termination. Now clean the dorsal digital veins which join the convex anterior border of the dorsal venous arch. They are four in number, one opposite each interdigital cleft. Follow them to the clefts, and trace their tributaries into the toes. The terminal part of the superficial peroneal nerve must now be secured. If either the communicating twig from the saphenous nerve to the most medial terminal branch of the superficial peroneal nerve was found, or the communicating branch from the sural nerve to the lateral terminal branch of the superficial peroneal nerve was found, follow one or the other of those branches upwards to the trunk. Otherwise cut down through the fat, at the junction of the middle and distal thirds of the leg, about 25 mm. to the medial side of the fibula, and secure the trunk of the superficial peroneal nerve as it pierces the deep fascia. Follow it distally to its division into medial and lateral branches, and then trace each of the branches and their subdivisions to their terminations on the toes. One of the subdivisions passes to the medial side of the great toe. A second passes to the cleft between the first and second toe; follow it with care, and find, springing from its medial side, a twig of communication to the medial division of the deep peroneal nerve. Follow the twig of communication, secure the medial division of the deep peroneal nerve, and follow its two terminal branches to the adjacent sides of the first and second toes.

Venæ Superficiales (the Cutaneous Veins of the Dorsum of the Foot and the Front of the Leg).—The cutaneous veins of the dorsum of the foot and the anterior region of the leg are the digital veins, the dorsal venous arch, and the parts of the great and small saphenous veins.

There are two *dorsal digital veins* in each toe, one on each side of the dorsum of the toe. The medial dorsal digital vein of the great toe joins with the medial end of the dorsal venous arch to form the commencement of the great saphenous vein, and the lateral dorsal digital vein of the little toe unites with the lateral end of the dorsal venous arch to form the small saphenous vein. The two dorsal digital veins which run along the adjacent sides of each of the four interdigital clefts unite at the apices of the clefts to form a common stem, and the four stems thus formed, which are sometimes called the common digital veins, end in the dorsal venous arch.

The *dorsal venous arch* lies in the superficial fascia on the anterior parts of the bodies of the metatarsal bones, superficial to the terminal branches of the superficial peroneal nerve. Its medial end, joining with the medial dorsal digital vein of the great toe, forms the commencement of the great saphenous vein, and its lateral end unites with the lateral dorsal digital vein of the little toe in the formation of the small saphenous vein.

The majority of the superficial veins of the front of the leg pass medially and upwards, and they terminate in the great saphenous vein, and as the great saphenous vein lies in front of the medial malleolus it receives tributaries from the medial side of the foot.

The Superficial Lymph Vessels of the Dorsum of the Foot and the Front of the Leg.—The main superficial lymph vessels accompany the veins. The greater part of the lymph from the dorsum of the foot passes along vessels which accompany the great saphenous vein to the distal set of superficial subinguinal lymph glands (p. 228), but some of the lymph vessels from the lateral border of the foot, and the lateral part of the dorsum, accompany the small saphenous vein and terminate in the lymph glands in the popliteal fossa. The lymph vessels from the front of the leg pass to the larger lymph vessels which accompany the great saphenous vein (Fig. 159).

Nervi Cutanei (the cutaneous nerves of the dorsum of the foot and the front of the leg).—The dissector should note that branches of three nerves supply the skin of the front of the leg, branches of three nerves supply the dorsum of the foot, and that the dorsal aspects of the toes are, for the main part, supplied by branches of three nerves, but that only one nerve, the superficial peroneal, is common to all three regions.

The proximal part of the front of the leg, below the patella, is supplied by the *infrapatellar branch of the saphenous nerve* (Figs. 107, 163).

The *lateral cutaneous nerve of the leg*, a branch of the *common peroneal nerve*, is distributed to the skin of the anterior surface from the infrapatellar region to the junction of the middle and distal thirds of the leg, and the remainder of the front of the leg is supplied by the *superficial peroneal nerve*.

The medial side of the dorsum of the foot is supplied by the *saphenous nerve*, the lateral side by the *sural nerve*, and the intermediate area by the superficial peroneal nerve.

The adjacent sides of the first and second toes are supplied by the *medial division* of the *deep peroneal nerve*, the lateral sides of the little toe by the *sural nerve*, and all the remaining parts by branches of the *superficial peroneal nerve*.

The skin over the terminal phalanges of the first, second, third and the medial part of the fourth toes is supplied by branches of the *medial plantar nerve*.

Nervus Peronæus Superficialis.—The superficial peroneal nerve pierces the deep fascia at the junction of the middle and distal thirds of the leg, and either at once or shortly afterwards it divides into a medial and a lateral division, which are quite unnecessarily called the medial and intermediate dorsal cutaneous nerves of the foot, the sural nerve, when it reaches the dorsum of the foot, being called the lateral dorsal cutaneous nerve of the foot to make the series complete. The medial division supplies the medial part of the dorsum of the foot and divides into two branches, one of which is distributed to the medial side of the great toe, and the other to the adjacent sides of the second and third toes; it also gives a communicating twig to the deep peroneal nerve (Fig. 107). The lateral division supplies the intermediate part of the dorsum of the foot, and also divides into two branches, one of which supplies the adjacent sides of the third and fourth toes, and the other, after receiving a twig from the sural nerve, supplies the adjacent sides of the fourth and fifth toes (Fig. 107). The branches of both divisions lie deep to the dorsal venous arch.

Nervus Suralis.—The sural nerve is formed at the back of the leg by the union of the anastomotic branch of the common peroneal nerve with the medial cutaneous nerve of the calf from the tibial nerve (Fig. 163). It accompanies the small saphenous vein, passes behind and below the lateral malleolus, and then runs along the lateral border of the foot, where it gives off a twig to the most lateral branch of the superficial peroneal nerve (Fig. 164), and then runs on to supply the lateral part of the dorsum of the little toe.

The account given above of the cutaneous nerves of the dorsum of the foot and toes indicates the general arrangement frequently met with, but the dissector must be prepared to meet with many variations, especially on the lateral side, where the sural nerve and the lateral division of the superficial peroneal nerve not uncommonly replace one another to a greater or a less extent.

***Dissection.*—After the cutaneous veins and nerves of the dorsum of the foot and the front of the leg have been examined, the remains of the fatty superficial fascia must be removed to display the deep fascia.**

Deep Fascia.—The deep fascia does not form a complete investment for the leg. It is absent over the medial area of the tibia, and is attached to the anterior and medial borders of that bone. It is also absent over the triangular subcutaneous surface on the distal part of the fibula, being attached to the ridges which limit that area anteriorly and posteriorly. It is not equally dense throughout, but becomes thinner towards the distal part of the leg until the region of the ankle is reached, where thickened bands are formed in it; beyond the ankle in the region of the dorsum of the foot it becomes exceedingly thin and fine. Its great strength in the proximal part of the anterior crural region is due to the fact that there it gives origin to fibres of the subjacent muscles. The bands in the region of the ankle are formed to retain the tendons in position when the muscles which move the joint are in action. Four of the bands must be examined at this stage of the dissection, viz., the ligamentum transversum cruris, the ligamentum cruciatum cruris, and the superior and inferior retinacula of the peroneal muscles.[1]

The *ligamentum transversum cruris* (O.T. *upper part of anterior annular ligament*) is a strong, broad band which stretches across the front of the leg, immediately proximal to the ankle joint. By one extremity it is attached to the fibula, and by the other to the tibia. The *lig. cruciatum cruris* (O.T. *lower part of anterior annular ligament*) is placed over the ankle joint. Laterally it presents the appearance of a narrow, well-defined band, which is fixed firmly to the anterior part of the calcaneus. As it passes medially it divides into two diverging limbs. Of these the proximal is attached to the medial malleolus, whilst the distal passes to the medial margin of the foot, and becomes connected with the plantar aponeurosis. The transverse and the cruciate ligaments of the leg are merely portions of the deep fascia which are distinguishable on account of their thickness (Figs. 153, 154).

The *superior peroneal retinaculum* is a thickened portion of the deep fascia which passes from the posterior and distal part of the lateral malleolus to the upper and posterior part of the lateral surface of the calcaneus (Fig. 158).

The *inferior peroneal retinaculum* springs from the anterior part of the upper surface of the calcaneus, where it is continuous with the lateral extremity of the cruciate ligament; its opposite extremity is attached, on the lateral border of the foot, to the trochlear process of the calcaneus and to the lateral surface of the calcaneus below that process. The

[1] In the old terminology the first two bands were respectively the upper and lower parts of the anterior annular ligament of the ankle, and the last two were included under the term external annular ligament.

peroneal retinacula bind the tendons of the peronæus longus and brevis to the lateral surface of the calcaneus (Fig. 158).

Intermuscular Septa.—As the deep fascia of the leg passes backwards over the fibular region, two strong intermuscular septa are given off from its deep surface. These are distinguished as the anterior and posterior fibular septa. The *anterior fibular septum* intervenes between the peroneal muscles and the extensor muscles of the toes, and is attached to the anterior crest of the fibula. The *posterior fibular septum* is interposed between the peroneal muscles and the muscles on the back of the leg, and is attached to the lateral crest of the fibula.

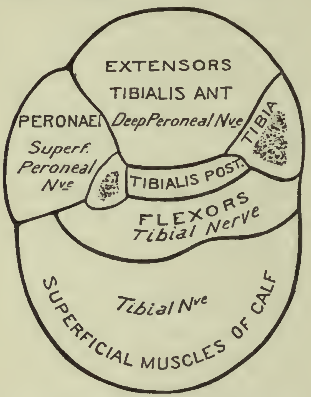


FIG. 152.—Diagrammatic representation of the Fascia of the Leg. The fascia of the tibialis posterior is more a muscular aponeurosis than a true fascial septum; but it is convenient for descriptive purposes to regard it as one of the partitions.

The leg is thus subdivided into three osteofascial compartments, corresponding to the anterior, lateral, and posterior crural regions. The *anterior compartment* is bounded by the investing deep fascia, the anterior fibular septum, the anterior part of the medial surface of the fibula (that part which lies anterior to the interosseous crest), the interosseous membrane, and the lateral surface of the tibia. The *lateral compartment* is bounded by the lateral surface of the fibula, the investing fascia, and the two fibular septa. The *posterior compartment*, which will be studied later, is much the largest; its walls are formed by the posterior surface of the tibia, the posterior part of the medial surface and the whole of the posterior surface of the fibula, the interosseous membrane, the posterior fibular septum, and the investing deep fascia.

Dissection.—The anterior compartment of the leg should now be opened by the removal of the deep fascia. The transverse and cruciate ligaments, however, must be retained, and their borders should be separated artificially, by the knife, from the deep fascia with which they are continuous. Great care must be taken not to injure the mucous sheaths of the tibialis anterior and the extensor tendons of the toes, when the margins of the transverse and cruciate ligaments are being defined, and whilst the deep fascia is being reflected. They lie close to the deep surface of the deep fascia. In the proximal part of the leg it will be found impossible to raise the deep fascia from the subjacent muscles without lacerating their surfaces. It should, therefore, be left in position. At a more distal level it can readily be separated. Divide it in a longitudinal direction midway between the tibia and fibula. Turn the medial piece to the medial side, until its attachment to the anterior border of the tibia is demonstrated; then turn the lateral piece to the lateral side, until its continuity with the anterior fibular septum is displayed.

After the medial and lateral attachments of the deep fascia have been studied attempt to distend the synovial sheaths of the tendons, either by inflation with a blow-pipe, or by the injection of some fluid by means of a small syringe. Three sheaths are to be examined; from the medial to the lateral side they are, the sheath of the tibialis anterior, the sheath of the extensor hallucis longus, and the sheath common to the extensor digitorum longus and the peronæus tertius (see Fig. 153, p. 342). If the blow-pipe is used make a small incision through the deep fascia of the foot into each sheath in turn, either between the two bands of the cruciate ligament or beyond the lower border of the cruciate ligament, and if a syringe is used insert the needle into the sheaths in the same regions. If inflation or injection fails, the positions and extents of the sheaths can be fairly satisfactorily demonstrated by the use of a blunt probe, introduced into the cavities of the sheaths through the openings made through their boundaries.

The Mucous Sheaths on the Dorsum of the Foot.—Three mucous sheaths are found in the region of the front of the ankle and on the dorsum of the foot—one round the tendon of the tibialis anterior, the second round the tendon of the extensor hallucis longus, and the third encloses the tendons of the extensor digitorum longus and the peronæus tertius. The first extends from the proximal border of the transverse ligament to within a short distance of the insertion of the tibialis anterior into the medial side of the first cuneiform bone. The second extends from behind the lower part of the transverse ligament to the first phalanx of the great toe; and the limits of the third are the lower border of the transverse ligament, proximally, and the middle of the dorsum of the foot distally. The sheaths facilitate the movements of the tendons behind the ligaments when the muscles are in action, and they are of surgical importance because they are liable to become inflamed.

After the mucous sheaths have been examined, the contents of the anterior crural compartment may be investigated.

Contents of the Anterior Crural Compartment.—Four muscles are brought into view when the deep fascia of the

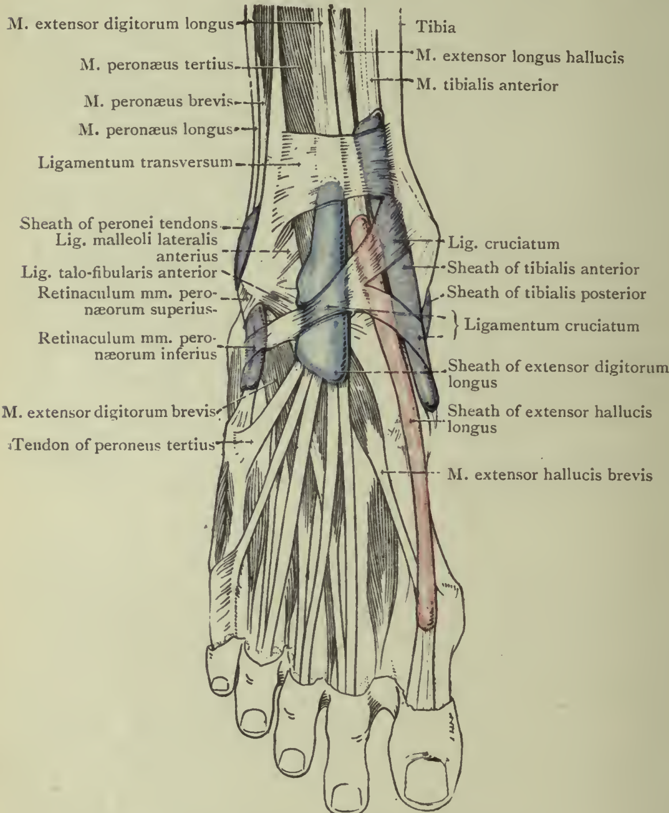


FIG. 153.—Mucous sheath of the Dorsum of the Foot.

front of the leg has been removed, viz., the tibialis anterior, the extensor digitorum longus, the extensor hallucis longus, and the peronæus tertius. The *tibialis anterior* lies in relation to the tibia; the *extensor digitorum longus* is placed along the fibula; and when those muscles are separated from one another the *extensor hallucis longus* will be seen in the interval between them. The *peronæus tertius* lies upon the distal portion of

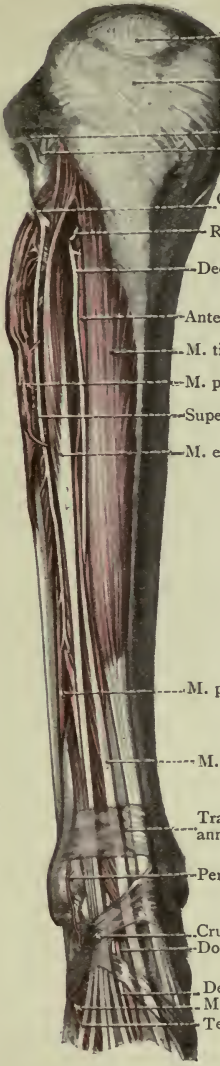


FIG. 154.—Dissection of the Anterior and Lateral Crural Regions.

the fibula, and in most cases is continuous with the extensor digitorum longus. The *anterior tibial vessels* and *the deep peroneal nerve* (O.T. *anterior tibial*) proceed distally in this compartment. At first they are deeply placed, but as they approach the ankle they come nearer to the surface.

Dissection.—To expose the anterior tibial vessels and the deep peroneal nerve in their entire course on the front of the leg, the tibialis anterior and the extensor digitorum longus must be separated from each other, along the line of a strong intermuscular septum which dips backwards between them, and affords a surface of origin to each. The knife should be carried proximally along the plane of this septum. If the peronæus tertius muscle is drawn aside, the *perforating branch of the peroneal artery* will be seen piercing the interosseous membrane. It is a small artery which descends upon the distal end of the fibula. As the structures in the anterior crural compartment are being exposed and cleaned, the dissector should, at the same time, carry on the dissection of the dorsum of the foot. There the tendons of the muscles on the front of the leg must be followed to their insertions, then the tendons of the extensor digitorum longus must be pulled aside in order that the extensor hallucis brevis and the extensor digitorum brevis, which lie deep to the tendons of the long extensor of the toes, may be cleaned and their tendons followed to their terminations. The dorsalis pedis artery, which is the continuation of the anterior tibial artery, and the deep peroneal nerve, and their branches, must also be cleaned and followed to their terminations.

M. Tibialis Anterior (O.T. **Tibialis Anticus**).—The tibialis anterior is a powerful muscle, which takes origin from the distal part of the lateral condyle of the tibia, and from the proximal half of the lateral surface of its body (Fig. 154, p. 343). It derives many fibres also from the deep fascia which covers it, from the fascial septum between it and the extensor digitorum longus, and from the portion of the interosseous membrane on which it rests. In other words, it springs from the structures which form the walls of the medial portion of the osteo-fascial compartment in which it lies.[1] A strong tendon issues from its fleshy belly in the distal third of the leg, and this reaches the dorsum of the foot by passing

[1] To understand the attachments of the muscles of the leg, it is necessary to bear in mind that the interosseous membrane, which stretches across the interval between the two bones of the leg, and thus extends the surface of origin for these muscles, is attached to the *interosseous* crest of the tibia (*i.e.* between its lateral and posterior surfaces) and to the interosseous crest of the fibula. The interosseous crest of the fibula traverses the medial surface of that bone, and divides it into an anterior and a posterior part. The anterior part gives origin to the extensor muscles and the posterior part to the tibialis posterior.

through both the transverse and cruciate ligaments. On the foot it inclines medially, and, turning round the medial margin, gains insertion, by two slips, into the medial and distal part of the first cuneiform bone, and into the adjoining part of the base of the first metatarsal bone. The tibialis anterior is supplied by the *deep peroneal nerve*. It is a dorsiflexor and an invertor of the foot.

M. Extensor Digitorum Longus.—The extensor longus digitorum muscle arises, for the most part, from the structures which form the lateral portion of the wall of the

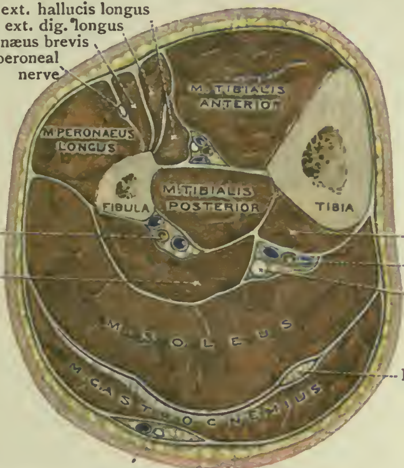


FIG. 155.—Transverse section through the Middle of the Leg.

anterior crural region. Thus, it springs from the distal part of the lateral condyle of the tibia, from the head of the fibula, and from the proximal three-fourths of the anterior part of the medial surface of the body of the fibula (Fig. 154, p. 343). It takes origin also from a small portion of the proximal part of the interosseous membrane, the deep investing fascia of the leg, the anterior fibular septum, and the inter-muscular septum which lies between it and the tibialis anterior. The tendon of the extensor digitorum longus descends anterior to the ankle joint, and, passing through the transverse and cruciate ligaments (p. 339), divides into four slips, which diverge from each other on the dorsum of the foot to reach the lateral four toes. On the dorsum of the first phalanx of each of the medial three of the lateral four toes each slip is joined, on its lateral side, by a tendon from the extensor digitorum brevis.

The manner in which the four tendons of the long extensor are inserted is similar, in all essential respects, to that in which the corresponding tendons of the fingers are attached, but there are slight differences, and as the dissector of the foot may not have dissected the hand a description of the conditions met with is necessary. The tendons of the extensor digitorum longus go to the second, third, fourth, and fifth toes, and those of the extensor digitorum brevis to the first, second, third, and fourth toes. In the cases of the second, third, and fourth toes the tendons of the long and short extensors unite, and the conjoined tendons form an expansion on the dorsal aspect of the first phalanx. The expansion is joined by the slender tendons of one lumbrical and two interossei, and then it divides into a central and two collateral parts. The slender central part is inserted into the base of the second phalanx; the stronger collateral parts are prolonged forwards, and, after they have united together, they are inserted into the base of the terminal phalanx; thus five tendons gain insertion into the dorsal aspects of the bases of each of the second and terminal phalanges of the second, third, and fourth toes, and movements become possible which could not be readily obtained in any other way, for whilst the flexor tendons flex the metacarpo-phalangeal joints the lumbricals and interossei can extend the interphalangeal joints by virtue of their connection with the extensor expansion. In the case of the foot this is not a very important matter, but in the case of the hand it is of extreme importance, for it is only by the means indicated that it is possible to place the fingers in the "writing position," and use them in the usual manner adopted for writing (see p. 178). The extensor digitorum longus is supplied by the *deep peroneal nerve*. It is an extensor of the interphalangeal and metatarso-phalangeal joints of the lateral four toes and it dorsi-flexes the foot.

M. Extensor Hallucis Longus.—The long extensor of the great toe is placed in the interval between the tibialis anterior and the extensor digitorum longus. In its proximal part it is hidden from view by those muscles, but near the ankle it comes to the surface. It takes origin posterior to the extensor digitorum longus, from an extremely narrow strip of the anterior part of the medial surface of the body of the fibula, in its middle two-fourths, and also from the adjoining part of the interosseous membrane. Its tendon passes deep to the transverse ligament, crosses in front of the distal part of the anterior tibial artery, and passing distally in front of the ankle joint reaches the dorsum of the foot deep to the cruciate ligament (Fig. 342). It is inserted into the dorsal aspect of the base of the ungual phalanx of the great toe.[1] It is *not joined* by the most medial tendon of the extensor digitorum brevis. The extensor hallucis longus is supplied by the *deep peroneal nerve.* It is an extensor of all the joints of the great toe and a dorsi-flexor of the foot.

M. Peronæus Tertius.—The peronæus tertius is a small muscle which is continuous at its origin with the extensor digitorum longus. It arises from the distal fourth of the anterior part of the medial surface ot the fibula, and from a corresponding extent of the interosseous membrane. It receives fibres also from the distal part of the anterior fibular septum, which intervenes between it and the peronæus brevis. Its slender tendon is inserted into the dorsal surface of the expanded base of the fifth metatarsal bone. It is supplied by the *deep peroneal nerve.* It is a dorsi-flexor of the ankle joint and an evertor of the foot.

Arteria Tibialis Anterior.—The anterior tibial artery is the smaller of the two terminal branches of the popliteal. It takes origin in the posterior region of the leg, at the distal border of the popliteus muscle, and at the level of the tuberosity of the tibia (see Fig. 135). It enters the anterior crural region by passing forwards through the opening in the proximal part of the interosseous membrane. As it passes forwards it lies close to the medial side of the neck of the fibula, where it appears in the present dissection. In the anterior part of the leg it takes a straight course distally to the ankle joint. Then it reaches the dorsum of the foot, and receives the name of *dorsalis pedis.*

In the proximal two-thirds of the leg the anterior tibial artery is very deeply placed. It lies upon the interosseous membrane, in the interval between the tibialis anterior on the medial side, and the extensor digitorum longus and the

[1] In most cases it gives a slip to the base of the proximal phalanx also.

extensor hallucis longus on the lateral side. In the distal third of the leg, where the muscles give place to their tendons, the artery comes nearer to the surface. In that part of its course it rests upon the tibia and is overlapped on the lateral side by the extensor hallucis longus. Immediately proximal to the ankle joint the tendon of the extensor hallucis longus crosses superficial to the artery and so comes to lie on its medial side.

Two *venæ comites* closely accompany the anterior tibial artery, and send short communicating branches both anterior and posterior to it. The *deep peroneal nerve* is also intimately related to it. It joins the artery a short distance distal to the knee, and soon takes up a position anterior to the vessel. Near the ankle joint the nerve, as a rule, again lies on the lateral side of the artery. Whilst the artery is still in the back part of the leg it gives off a fibular and a posterior tibial recurrent branch which will be seen in a subsequent dissection (see p. 403).

On the front of the leg the anterior tibial artery gives off the following *branches* :—

1. Muscular.
2. A. recurrens tibialis anterior.
3. A. malleolaris anterior medialis.
4. A. malleolaris anterior lateralis.

The *muscular branches* are numerous, and come off at irregular points along the whole length of the artery. They supply the muscles of the *anterior crural region.*

The **anterior tibial recurrent artery** is a small vessel which springs from the anterior tibial immediately after it reaches the front of the leg. It turns proximally, on the lateral condyle of the tibia, in the fibres of the tibialis anterior muscle. Its terminal twigs reach the front of the knee joint, and anastomose with the inferior genicular branches of the popliteal artery.

Malleolar Arteries.—These arteries take origin immediately proximal to the ankle joint. The *lateral anterior malleolar artery* is the larger of the two. It passes laterally under cover of the tendons of the extensor digitorum longus and peronæus tertius, to reach the lateral surface of the lateral malleolus, and it anastomoses with the perforating branch of the peroneal artery and with the lateral tarsal artery. The *medial anterior malleolar artery* runs medially, under cover of the tendons of the extensor hallucis longus and tibialis anterior. It inosculates with branches from the posterior tibial artery.

Arteria Dorsalis Pedis.—The dorsal artery of the foot is the continuation of the anterior tibial. It begins, anterior to the ankle joint, at a point midway between the two malleoli, and it extends forwards, upon the dorsal part of the talus, and across the navicular, and the second cuneiform bone, to the posterior part of the first interosseous space. There it leaves the dorsum of the foot, by dipping plantarwards between the two heads of the first dorsal interosseous muscle, to reach the plantar region, where it unites with the lateral plantar artery in the formation of the plantar arch. Its relations on the dorsum of the foot are very simple. (1) It lies in the interval between the tendon of the extensor hallucis longus on the medial side and the most medial tendon of the extensor digitorum longus on the lateral side. (2) It is crossed first by the proximal band of the cruciate ligament, then by the distal band, and near its termination it is crossed by the tendon of the extensor hallucis brevis; with those exceptions the vessel is covered merely by the integu-

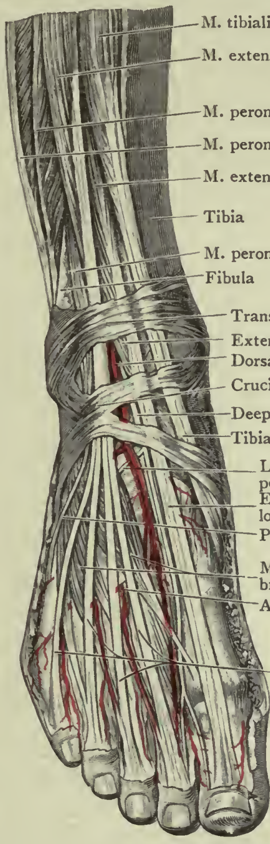


FIG. 156.—Dissection of the Dorsum of the Foot.

ment and fasciæ. (3) The medial terminal branch of the deep peroneal nerve lies along its lateral side,[1] and two *venæ comites* accompany it.

As the dorsalis pedis artery traverses the dorsum of the foot it gives off several twigs to the medial margin of the foot, and three named branches which pass laterally:—

1. Aa. tarseæ mediales.
2. A. tarsea lateralis.
3. A. arcuata.
4. A. metatarsea dorsalis prima.

Arteriæ Tarseæ Mediales.—The medial tarsal branches two or more in number, spring from the medial side of the dorsalis pedis and descend across the medial border of the foot to anastomose with branches of the medial plantar artery.

A. Tarsea Lateralis et A. Arcuata (O.T. **Tarsal and Metatarsal**).—The *lateral tarsal artery* arises opposite the navicular bone, and the *arcuate artery* arises near the bases of the metatarsal bones. They both run laterally, under cover of the extensor hallucis brevis and the extensor digitorum brevis, to reach the lateral margin of the foot. There they anastomose with branches of the lateral plantar artery. The lateral tarsal artery anastomoses also with the lateral malleolar and peroneal arteries.

From the arch which is formed by the arcuate artery *three dorsal metatarsal arteries* proceed, one to each of the lateral three interosseous spaces, and at the clefts between the toes they divide and supply *dorsal digital twigs* to the adjacent sides of the second, third, fourth, and fifth toes. From the most lateral dorsal metatarsal artery a twig is given to the lateral side of the little toe.

A. Metatarsea Dorsalis Prima (O.T. **First Dorsal Interosseous**).—The first dorsal metatarsal artery is a small vessel which takes origin from the dorsalis pedis, at the point where that vessel turns plantarwards to reach the plantar region of the foot. From its origin it continues forwards, upon the first dorsal interosseous muscle, and divides into *dorsal digital branches* for the medial side of the great toe and the adjacent sides of the great toe and second toe.[2]

Perforating Branch of Peroneal Artery (O.T. **Anterior**

[1] The nerve sometimes descends along its medial side.

[2] For the branches from the dorsalis pedis in the plantar region see p. 398.

Peroneal Artery).—This branch of the peroneal artery arises in the posterior region of the leg. It pierces the interosseous membrane from 35 to 50 mm. above the lateral malleolus, and so enters the anterior region. There it descends upon the distal part of the fibula, under cover of the peronæus tertius, and its terminal branches anastomose with the lateral malleolar and lateral tarsal arteries.

Mm. Extensor Hallucis Brevis et Extensor Digitorum Brevis.—The short extensor of the great toe and the short extensor of the toes may now be examined. They are the muscles which form the fleshy cushion on the dorsum of the foot. They arise together from the anterior part of the dorsal surface of the calcaneus, immediately posterior to the cuboid bone, and also from the stem of the cruciate ligament. The common muscular mass breaks up into four segments. The most medial of the four is called the *short extensor of the great toe.* It ends in a tendon which is inserted into the base of the first phalanx of the great toe. On its way from its origin to its insertion it crosses the superficial surface of the distal part of the dorsalis pedis artery. It is supplied by the lateral branch of the deep peroneal nerve and it is an extensor of the metatarso-phalangeal joint of the great toe.

The remaining three segments of the muscular mass are described collectively as the *short extensor of the toes.* They end in tendons which join the long extensor tendons going to the second, third, and fourth toes, and, by means of the extensor expansion (see p. 346), they gain insertion into the second and terminal phalanges of those toes. The short extensor of the toes like the extensor hallucis brevis is supplied by the lateral branch of the deep peroneal nerve, and it acts as an extensor of the interphalangeal and metatarso-phalangeal joints of the toes to which it is distributed.

Nervus Peronæus Profundus (O.T. **Anterior Tibial).**—The deep peroneal nerve is one of the terminal branches of the common peroneal nerve. It arises between the proximal part of the peronæus longus and the neck of the fibula, then it pierces the anterior fibular septum and the extensor digitorum longus, and so enters the anterior compartment of the leg. In that compartment it descends obliquely until it joins the anterior tibial vessels, a short distance distal to the lateral condyle of the tibia. In the remainder of its course it accompanies the anterior tibial vessels, in the first instance lying lateral to them, then anterior; but near the ankle joint it again, as a rule, lies on their lateral side. It passes posterior to the transverse and cruciate ligaments, and ends by dividing into a medial and a lateral branch.

In its course through the leg the deep peroneal nerve gives *muscular branches* to the extensor digitorum longus, the tibialis anterior, the extensor hallucis longus, and the peronæus tertius; and a fine *articular twig* to the ankle joint.

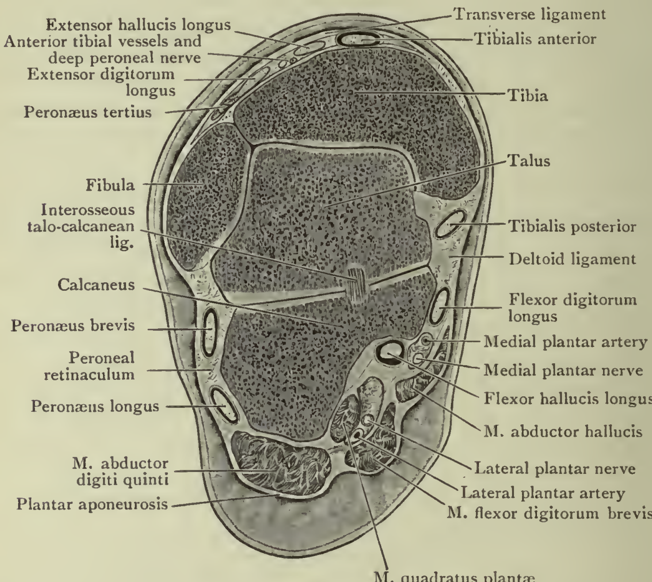


FIG. 157.—Frontal section through the Left Ankle Joint, Talus, and Calcaneus (Paterson).

The *medial terminal branch* of the deep peroneal nerve is continued forwards upon the dorsum of the foot along the lateral side of the dorsalis pedis artery.[1] At the posterior end of the first interosseous space, it pierces the deep fascia, and divides to supply the contiguous margins of the great toe and the second toe (p. 337). Before it reaches the surface, it furnishes *articular twigs* to the tarso-metatarsal and metatarso-

[1] Not uncommonly it crosses superficial to the artery and descends along its medial side.

phalangeal joints of the great toe, and frequently, also, a fine *muscular twig* to the dorsal surface of the first dorsal interosseous muscle.

The *lateral terminal branch* of the deep peroneal nerve turns abruptly laterally, under cover of the extensor digitorum brevis, and ends on the dorsum of the tarsus in a gangliform enlargement. Branches proceed from the enlargement to supply the extensor digitorum brevis and the numerous articulations in the neighbourhood. One fine filament can, in some cases, be traced to the second dorsal interosseous muscle. The terminal swelling resembles closely the corresponding enlargement in which the dorsal interosseous nerve of the superior extremity ends (see p. 185).

Ligamentum Transversum Cruris et Ligamentum Cruciatum (O.T. **Anterior Annular Ligament).**—The dissector should now re-examine the transverse and cruciate ligaments, and the arrangement of the structures which pass deep to them. The *transverse ligament* is attached to the fibula by its lateral end, and to the tibia by its medial extremity. If the fibular attachment is divided, and the ligament is thrown medially, it will be seen to contain a distinct compartment for the tibialis anterior and its mucous sheath.

The *cruciate ligament* is the more important of the two. Its attachments have already been noted (p. 339). Examine the manner in which it holds the tendons in position. It consists of two layers, and these, by separating at certain points and becoming reunited at others, form three distinct compartments. The tendon of the tibialis anterior passes through the *medial* compartment, the tendon of the extensor hallucis longus traverses the *intermediate* one, and the tendons of the extensor digitorum longus and peronæus tertius are transmitted through the *lateral* compartment. As the tendons pass through the compartments of the ligaments, and for some distance proximal to the transverse ligament and distal to the cruciate ligament, they are surrounded by mucous sheaths (see p. 341). Lastly, note the position of the anterior tibial vessels and the deep peroneal nerve as they pass under cover of the ligaments. They lie between the extensor hallucis longus and the extensor digitorum longus (Fig. 156, p. 349).

Peroneal or Lateral Crural Region.

Before the peroneal region is opened up, the dissector should examine the mucous sheaths of the tendons of the peronæus longus and brevis. Behind and below the lateral malleolus the two tendons are enclosed in a common sheath, but immediately posterior to the trochlear process of the calcaneus the common sheath is separated into two portions,

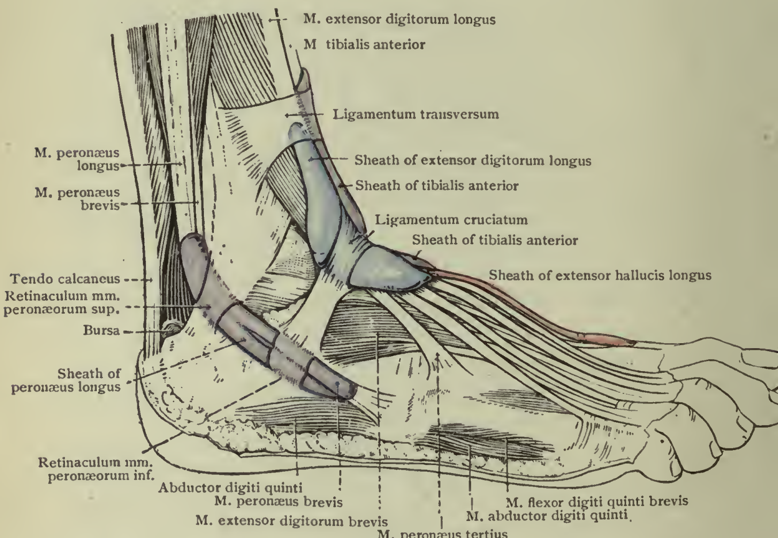


Fig. 158.—Dissection of Leg and Foot showing Mucous Sheath of Tendons.

one for each tendon (Fig. 158). The upper portion, which surrounds the continuation of the peronæus brevis tendon, extends forwards almost to the insertion of the tendon into the base of the fifth metatarsal bone. The lower portion, which surrounds the continuation of the peronæus longus tendon, may accompany that tendon to its insertion into the lateral side of the base of the first metatarsal bone, or it may end, at the lateral border of the cuboid bone, as the tendon turns medially into the sole of the foot. In the latter case the part of the tendon which lies in the sole has a separate mucous sheath. The sheaths should either be inflated, or injected, or examined with a probe in the manner indicated when the sheaths of the extensors were described (see p. 341).

Dissection.—After the mucous sheaths of the peronæi tendons have been examined, the lateral compartment of the leg must be opened up to display its contents. Divide the deep fascia over the peronæi muscles by a longitudinal incision, and turn the flaps aside until their continuity with the anterior and posterior fibular septa is demonstrated, but do not injure the peroneal retinacula.

Enclosed within the lateral compartment of the leg are the following structures:—

1. The peronæus longus.
2. The peronæus brevis.
3. The termination of the common peroneal nerve.
4. The superficial peroneal nerve.

M. Peronæus Longus.—The peronæus longus muscle arises from the head and from the lateral surface of the shaft of the fibula in its proximal two-thirds. Surfaces of origin are also afforded to it by the fascia which covers it, and by the two fibular intermuscular septa. It ends, a short distance proximal to the ankle, in a long tendon, which is continued distally posterior to the lateral malleolus. Gaining the lateral border of the foot, it proceeds forwards, on the lateral surface of the calcaneus, to the groove on the plantar surface of the cuboid, which conducts it obliquely into the sole. Its insertion will be examined at a later period (see p. 400). It is supplied by the *superficial peroneal nerve* (O.T. *musculo-cutaneous*) and is a plantar flexor and evertor of the foot.

M. Peronæus Brevis.—The peronæus brevis muscle arises from the distal two-thirds of the lateral surface of the body of the fibula, anterior and distal to the peronæus longus, and from the fibular intermuscular septum on each side of it. Its tendon descends, posterior to the lateral malleolus, and then turns forwards, on the lateral surface of the calcaneus, to gain an insertion into the projecting base of the metatarsal bone of the little toe.[1]

As the tendons of the two peronæi muscles proceed distally, in the hollow between the lateral malleolus and the posterior prominence of the calcaneus, they are held in place by the *superior peroneal retinaculum*, and their movements are

[1] A small tendinous slip will, sometimes, be observed to proceed forwards from the tendon of the peronæus brevis to join the tendon of the long extensor on the dorsum of the little toe. This is the *peronæus digiti quinti*.

facilitated by the presence of a common mucous sheath. On the lateral surface of the calcaneus the tendons are retained in position by the *inferior peroneal retinaculum*, but each tendon lies in a separate compartment surrounded by its own special prolongation of the mucous sheath. At the back of the lateral malleolus, the tendon of the peronæus brevis is anterior to the tendon of the peronæus longus and therefore between it and the fibula, consequently as the two tendons turn forwards along the lateral side of the calcaneus the tendon of the peronæus brevis occupies a higher position than the tendon of the peronæus longus and passes above the trochlear process of the calcaneus, which intervenes between the mucous sheaths of the two tendons. The peronæus brevis is supplied by the *superficial peroneal nerve*. It is a plantar flexor and an evertor of the foot.

N. Peronæus Communis (O.T. External Popliteal Nerve).—The common peroneal nerve has previously been traced as far as the neck of the fibula. At that point it disappears from view by passing forwards between the peronæus longus muscle and the bone. The muscle must therefore be carefully turned aside from its origin in order that the nerve may be followed to its termination. As it lies between the peronæus longus and the neck of the fibula it gives off a small *recurrent articular branch* to the knee joint, and then divides into the *deep* and *superficial peroneal nerves*.

The *recurrent branch* pierces the extensor digitorum longus, and then accompanies the anterior tibial recurrent artery through the upper fibres of the tibialis anterior. It gives twigs to the tibialis anterior, but its terminal filaments are distributed to the synovial stratum of the capsule of the knee joint.

The *deep peroneal nerve* pierces the proximal part of the extensor digitorum longus to reach the anterior region of the leg, where it has already been dissected.

N. Peronæus Superficialis (O.T. Musculo-Cutaneous Nerve).—The superficial peroneal nerve passes distally in the substance of the peronæus longus; reaches the interval between the two peronæi muscles; gives branches to both; and then lies between the peronæus brevis and the extensor digitorum longus. In the distal third of the leg it pierces the deep fascia, becomes cutaneous, and divides into a medial and a lateral branch, which have been called the medial and intermediate dorsal cutaneous nerves of the foot (p. 338).

Medial Crural Region.

This region corresponds to the subcutaneous or medial surface of the tibia. The deep fascia blends with the periosteum of the bone, and the structures which have to be examined are:—

1. The great saphenous vein.
2. The saphenous nerve.
3. The expanded tendons of insertion of the sartorius, semitendinosus, and gracilis.
4. The tibial collateral ligament of the knee joint.
5. The inferior medial genicular artery.
6. The inferior medial articular nerve.

***Dissection.*—The great saphenous vein and the saphenous nerve have already been cleaned where they lie upon the distal third of the medial surface of the tibia. Now remove the remains of the superficial fascia from the region of the medial surface of the tibia, then again examine the insertions of the sartorius, gracilis, and semitendinosus.**

The expanded terminal parts of the tendons of the sartorius, gracilis, and semitendinosus are all inserted into the proximal third of the medial surface of the tibia. Note how the sartorius overlaps the tendons of the other two, and how the tendon of the gracilis overlaps the proximal part of the tendon of the semitendinosus. Mucous bursæ separate the tendons from each other.

Under cover of the sartorius, gracilis, and semitendinosus, and separated from them by a bursa, the *tibial collateral ligament* of the knee joint extends distally, for a short distance, upon the medial aspect of the body of the tibia. Passing forwards under cover of the ligament, so as to gain the anterior aspect of the knee, are the *inferior medial genicular vessels* and the *inferior medial articular nerve.*

As the great saphenous vein and the saphenous nerve cross the distal third of the medial surface of the tibia, they are very liable to injury because they lie quite superficially between the skin and the bone.

Posterior Crural Region.

The following is a list of the structures which are met with in this dissection:—

1. Superficial veins, { Great saphenous vein. Small saphenous vein.
2. Cutaneous nerves.
3. Deep fascia.
4. Superficial muscles of the calf, { Gastrocnemius. Plantaris. Soleus.
5. Tendo calcaneus (Achillis) and its bursa.
6. Posterior tibial vessels.
7. Tibial nerve.
8. Deep muscles, { Popliteus. Flexor hallucis longus. Tibialis posterior. Flexor digitorum longus.
9. Ligamentum laciniatum.

***Dissection.*—Reflection of Skin.**—The limb must now be placed on its anterior aspect, and the muscles of the calf rendered tense by dorsi-flexing the foot at the ankle joint. That position should be maintained by the aid of hooks, fastened to the toes and to the under surface of the table. The skin has already been reflected to the medial and lateral borders of the leg and foot. Now make a transverse incision across the distal part of the heel and carry the extremities of the incision forwards, along the medial and lateral borders of the foot respectively, then remove the skin from the whole of the back of the leg, commencing the reflection either from the medial or lateral border as may be most convenient. As the reflection proceeds keep the edge of the knife always against the skin to avoid injury to the superficial veins and nerves.

Superficial Fascia.—The superficial fascia of the posterior crural region presents no special or peculiar features, but it contains the following structures which must be displayed by the dissector:—

Superficial veins, { Part of the great saphenous vein. Part of the small saphenous vein.

Superficial lymph vessels.

Cutaneous nerves, { Part of the saphenous nerve. The terminal part of the posterior branch of the medial cutaneous nerve of the thigh. The terminal part of the posterior cutaneous nerve of the thigh. The medial cutaneous nerve of the calf. The anastomotic peroneal nerve. The sural nerve. The medial calcanean nerves.

Dissection.—The superficial veins and the cutaneous nerves must now be followed and cleaned. The lymph vessels cannot be demonstrated in an ordinary dissection; the majority of them accompany the veins and their tributaries. The great saphenous vein and the saphenous nerve have already been traced across the distal third of the medial surface of the tibia

(p. 336). Now follow them proximally along the posterior margin of the medial surface of the tibia to the medial side of the knee, where they were displayed when the superficial part of the medial region of the thigh was dissected (p. 227). The vein and nerve lie close together.

The posterior branch of the medial cutaneous nerve of the thigh was also found when the medial side of the thigh was dissected. In the calf it lies lateral and posterior to the saphenous nerve, and should now be traced to its termination in the area of the medial head of the gastrocnemius (Fig. 161).

The terminal part of the posterior cutaneous nerve of the thigh was found when the popliteal area was being dissected (p. 306). It pierces the popliteal part of the deep fascia a little below the middle of its length, and should now be traced as it descends through the superficial fascia to the middle of the calf (Fig. 161). Deep to the terminal part of the posterior cutaneous nerve of the thigh, in the groove between the two heads of the gastrocnemius, lie the upper part of the small saphenous vein and the medial cutaneous nerve of the calf. Both structures have been already partially investigated. When the popliteal fossa (p. 309) was dissected the vein was found piercing the popliteal fascia and ending in the popliteal vein, whilst the nerve was found arising from the tibial nerve ; and, in the dissection of the dorsum of the foot (p. 336), the vein was seen commencing from the lateral end of the dorsal venous arch, whence it passed backwards below, and upwards behind the lateral malleolus. The remaining part of the vein must now be cleaned. It ascends along the lateral border of the tendo calcaneus, accompanied by the sural nerve, and then in the groove between the two heads of the gastrocnemius, accompanied by the medial cutaneous nerve of the calf. The sural nerve was found, in a previous dissection (p. 338), lying in close association with the small saphenous vein behind the lateral malleolus. Trace it upwards to the point where it is formed by the union of the medial cutaneous nerve of the calf and the anastomotic peroneal nerve; the union usually takes place at the lateral border of the proximal part of the tendo calcaneus. From the commencement of the sural nerve follow the medial cutaneous nerve of the calf upwards to the point where it pierces the deep fascia, about midway between the knee and the ankle, then follow the peroneal anastomotic nerve to the point where it pierces the deep fascia in the proximal part of the calf, superficial to the lateral head of the gastrocnemius (Fig. 161). The medial calcanean nerves will be found piercing the thickened portion of deep fascia called the ligamentum laciniatum which crosses the interval between the medial malleolus and the calcaneus. They are accompanied by small branches of the posterior tibial artery.

At this stage the dissector should revise the saphenous veins and the cutaneous nerves which have been seen in previous dissections, but which are now, for the first time, displayed from beginning to end (Figs. 163, 164, 107).

Vena Saphena Magna.—The great saphenous vein commences at the medial border of the foot, where it is formed by the union of the medial end of the dorsal venous arch of the foot with the medial digital vein of the great toe. It ascends anterior to the medial malleolus, passes obliquely upwards and backwards across the medial surface of the distal third of the tibia, and then vertically upwards, along the medial border of the tibia, to the posterior part of the medial side of the knee. Thence it passes obliquely upwards, forwards, and laterally, through the superficial fascia of the medial and anterior areas of the thigh, to the fossa ovalis, where it pierces the cribriform fascia and the femoral sheath and terminates in the femoral vein (Figs. 163, 107, 106).

Its named tributaries are the dorsal venous arch, the medial digital vein of the great toe, the lateral and medial femoral circumflex veins (p. 230), the superficial pudendal, epigastric, and circumflex iliac veins (p. 230), but it receives in addition numerous other tributaries from the dorsum of the foot, and from the front, medial side, and back of the leg. Further, it forms numerous communications with the deep veins of the limb by anastomosing channels which pierce the deep fascia. A fairly large communicating vein pierces the ligamentum laciniatum and curves below the medial malleolus to join the great saphenous vein at the anterior border of that process; others pierce the deep fascia along the medial borders of the tibia and in the distal third of the thigh.

The great saphenous vein is accompanied by numerous superficial lymph vessels. They drain the regions from which the tributaries of the vein issue, and they terminate in the medial and lateral groups of subinguinal lymph glands, which lie at the sides of the proximal part of the vein in the region of the femoral triangle. It is also accompanied by several cutaneous nerves—from the fossa ovalis to the middle of the thigh by branches of the medial cutaneous nerve of the thigh, from the middle of the thigh to the knee by the anterior terminal branch of the medial cutaneous nerve of the thigh, and from the knee to the medial border of the foot by the saphenous nerve.

It contains a number of valves which help to divide the long column of blood into a series of segments, and so diminish the pressure on the walls of the more distal parts of the vein.

Vena Saphena Parva.—The small saphenous vein is formed, in the lateral border of the foot, by the union of the lateral digital vein of the little toe with the lateral end of the dorsal venous arch of the foot. From its point of commencement it runs backwards below the lateral malleolus, and then upwards behind the lateral malleolus, in company with the sural nerve, and superficial to the peroneal retinacula. Afterwards it ascends, parallel with the lateral border of the tendo calcaneus, where it is still associated with the sural nerve. Above the level of the tendo calcaneus it ascends along the median line of the calf to the lower part of the popliteal region, where it pierces the popliteal fascia and terminates in the popliteal vein. In the lower part of its ascent along the median line of the calf it is associated with the medial cutaneous nerve of the calf, and in the upper part by the distal portion of the posterior cutaneous nerve of the thigh. The small saphenous vein receives tributaries from the lateral border of the foot, the heel, and the back of the calf. It is accompanied by superficial lymph vessels which commence in the areas in which the tributaries of the vein arise, and which terminate in the popliteal lymph glands (Figs. 163, 164).

The two saphenous veins are connected together by the medial femoral circumflex vein, which commences from the small saphenous vein, immediately before it pierces the deep fascia, and terminates in the great saphenous vein above the middle of the thigh. In some cases the medial femoral circumflex vein forms the direct continuation of the small saphenous vein, and in those cases the small saphenous vein has either only a very small connection, or no connection at all, with the popliteal vein.

The Lymph Vessels and Lymph Glands of the Inferior Extremity.—The lymph vessels of the inferior extremity cannot be displayed in an ordinary "part," but some at least of the lymph glands are always found, and as both lymph vessels and lymph glands are of great practical importance, it is essential that the dissector should have a general knowledge of their positions and functions. The lymph vessels contain a colourless fluid called *lymph*, which drains into their finer tributaries from the surrounding tissues. Micro-organisms which have gained access to the tissues, and the cells of malignant tumours growing in the tissues, may enter the lymph vessels and so be carried onwards in the lymph stream. The lymph carried by the lymph vessels eventually passes into two terminal trunks, the *thoracic duct* and the right lymph duct, each of which terminates in a large vein; therefore the lymph, and micro-organisms or poisons formed by micro-organisms which have entered the lymph, are eventually poured into the blood, and by it are dispersed to all parts of the body. Both terminal lymph vessels end at the root of the neck behind the sternal end of the clavicle, the thoracic duct in the left innominate vein and the right lymph duct in the right innominate vein (Fig. 14).

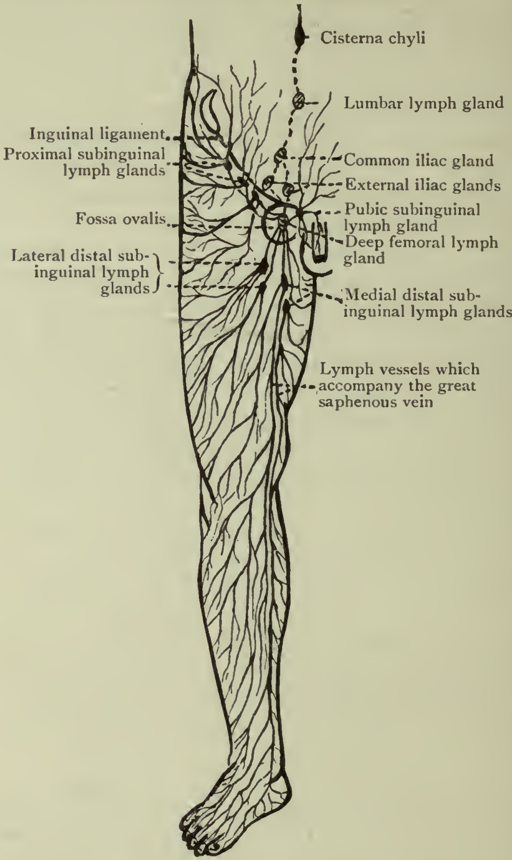


FIG. 159.—Diagram of the Lymph Vessels of the front of the Inferior Extremity.

All the lymph, however, before it reaches the terminal lymph vessels, passes through one or several lymph glands, usually several, for the glands are interposed, like small filtering sponges, in the courses of the lymph vessels; therefore the lymph collected from the tissues is carried in the first instance to a lymph gland, and then, as a rule, it passes through several other glands before it reaches terminal lymph vessels. The lymph vessels which carry lymph to a gland are called *afferent lymph vessels*, and those which carry it away are *efferent lymph vessels*. All the lymph from both inferior extremities flows to the commencement of the thoracic duct which lies in the abdominal region in front of the second lumbar vertebra, where it frequently possesses a dilated extremity called the *cisterna chyli*. On its way it passes through a series of glands, and as noxious materials which have entered the lymph vessels may be caught in the glands and there set up inflammation or produce new malignant growths, it is important to bear in mind constantly the general positions of the glands and the areas from which they receive lymph.

There are two sets of lymph vessels and lymph glands in the inferior extremity, the deep and the superficial.

The deep lymph glands are, (1) the anterior tibial, (2) the popliteal, (3) the deep subinguinal. The anterior tibial gland lies close to the proximal end of the anterior tibial artery in the anterior compartment of the leg. The popliteal glands lie in the popliteal fossa around the popliteal vessels. The deep subinguinal glands are situated in the femoral triangle, in the femoral canal of the femoral sheath. The deep lymph vessels which pass to the deep glands run along the main blood-vessels, and they carry lymph drained from all the deeper structures of the limb, the muscles, ligaments, bones, and joints. The lymph from the deep parts of the leg, foot, and knee passes through the popliteal glands to the deep subinguinal glands; that from the medial, anterior, and lateral parts of the thigh is carried to the deep subinguinal glands; but the lymph from the deep parts of the back of the thigh and the buttock, flowing through lymph vessels which accompany the inferior and superior gluteal vessels, passes into the pelvis to the hypogastric glands, and through them to the common iliac and lumbar glands on its way to the thoracic duct.

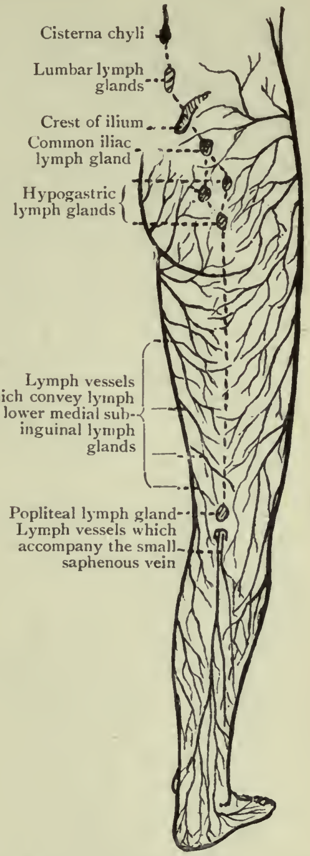


FIG. 160.—Diagram of the Lymph Vessels of the back of the Inferior Extremity.

The superficial lymph glands of the inferior extremity are the subinguinal lymph glands to which attention was directed in association with the superficial dissection of the anterior part of the thigh (see p. 228). They form two groups, a proximal and a distal. The proximal group was found lying parallel with and close to the inguinal ligament, and the distal group at the sides of the proximal part of the great saphenous vein (Figs. 106, 159).

All the lymph from the skin and the subcutaneous structures of the inferior extremity, except that derived from the lateral side of the foot, the back of the heel, and the back of the leg, passes through one or other of the two groups of superficial subinguinal glands, and from them it is carried to the deep subinguinal glands by efferent vessels which pierce the cribriform fascia and the anterior wall of the femoral sheath. The lymph from the dorsum and medial side of the foot, the front and medial side of the leg, the medial side and the greater part of the front of the thigh, is conveyed to larger lymph vessels which accompany the great saphenous vein and end in the distal subinguinal glands. The lymph from the buttock and back of the thigh flows to the proximal subinguinal glands. The lymph from the lateral side of the foot, the back of the heel and the leg, passes into lymph vessels which accompany the small saphenous vein and terminate in the popliteal lymph glands.

It follows, from what has already been stated, that all the lymph of the inferior extremity, except that from the deep parts of the buttock and back of the thigh, passes through the deep subinguinal glands. From the deep subinguinal glands the lymph passes into the external iliac glands, which lie in the lower and anterior part of the abdomen close to the inferior end of the external iliac artery and immediately above the inguinal ligament, and from them it is conveyed through the common iliac glands, which lie at a higher level, to the lumbar glands. The lumbar glands are situated still higher in the abdomen opposite the lumbar vertebræ at the sides of the aorta, and they are the last glands through which the lymph of the inferior extremities passes before it enters the thoracic duct (Figs. 159, 160).

Nervi Cutanei.—Before proceeding to display the deep fascia of the back of the leg the dissector should revise the numerous cutaneous nerves.

N. Saphenus.—The saphenous nerve is the most medial of the deeper group of branches of the femoral nerve. It commences therefore in the femoral triangle, where it descends along the lateral border of the femoral artery; it accompanies the artery through the adductor canal, lying first on its lateral side, then in front of it, and finally in the distal part of the canal on its medial side. It does not accompany the artery through the opening in the adductor magnus, but, at the distal end of the adductor canal it passes between the sartorius and gracilis muscles accompanied by the saphenous branch of the arteria genu suprema. At the medial side of the knee it pierces the deep fascia, enters the superficial fascia, and then it accompanies the great saphenous vein to the medial border of the foot. In the adductor canal it gives twigs to the subsartorial plexus. After it leaves the canal, and before it emerges between the sartorius and gracilis, it gives off an infrapatellar branch, which pierces the sartorius on its way to the patellar plexus. Beyond the knee its branches are distributed to the skin of the medial side of the leg, including the medial crural region, the medial part of the posterior crural region, and the medial part of the dorsum of the foot.

N. Cutaneus Suræ Medialis. — The medial cutaneous nerve of the calf springs from the tibial nerve in the popliteal fossa, descends between the two heads of the gastrocnemius, pierces the deep fascia of the leg, about midway between the knee and the ankle, and unites with the anastomotic branch of the peroneal nerve to form the sural nerve at the lateral border of the proximal part of the tendo calcaneus. It supplies the skin of the middle part of the calf of the leg.

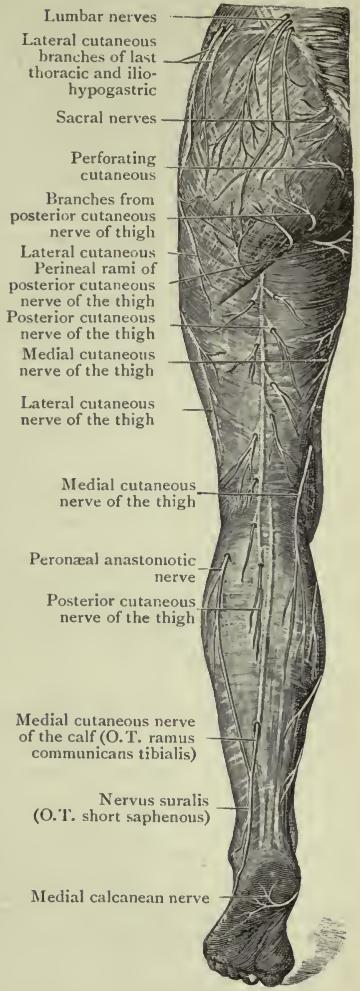


FIG. 161.—Cutaneous Nerves on the posterior aspect of the Inferior Extremity.

N. Anastomoticus Peronæus.—The anastomotic branch of the common peroneal nerve springs from the common peroneal nerve in the popliteal fossa, crosses superficial to the lateral head of the gastrocnemius, where, as a rule, it pierces the deep fascia; then it passes downwards and medially to the proximal end of the lateral border of the tendo calcaneus, where it joins with the medial cutaneous nerve of the calf in the formation of the sural nerve. It supplies the skin of the proximal two-thirds of the posterior surface of the calf.

N. Suralis.—The sural nerve is formed, by the union of the anastomotic branch of the peroneal nerve and the medial cutaneous nerve of the calf, in the superficial fascia at the level of the proximal end of the lateral border of the tendo calcaneus. It descends, alongside of the small saphenous vein, behind the lateral malleolus; then it turns forwards, below the lateral malleolus, to the lateral border of the dorsum of the foot; there it gives a communicating twig to the branch of the superficial peroneal nerve which is distributed in the adjacent sides of the fourth and fifth toes, and then continues forwards to the lateral part of the dorsum of the little toe. In the region of the dorsum of the foot it is known as the lateral dorsal cutaneous nerve of the foot, a superfluous and unnecessary term.

The medial cutaneous nerve of the thigh, the posterior cutaneous nerve of the thigh, and the lateral cutaneous nerve of the leg have already been sufficiently described (see pp. 257, 306, 315).

> ***Dissection.***—**After the cutaneous veins and nerves of the posterior region of the leg have been studied, remove the remains of the fatty superficial fascia, and clean the deep fascia which lies subjacent to it.**

Deep Fascia.—In the proximal part of the calf the deep fascia is thin and transparent; it thickens considerably as the region of the heel is approached. In no part of its extent is it very dense, but as it passes from the back of the leg to the medial side of the ankle, and covers the interval between the medial malleolus and the calcaneus, it is greatly strengthened to form the ligamentum laciniatum (O.T. internal annular ligament), whilst at the lateral side of the ankle it is also thickened to form the peroneal retinacula (p. 339).

It is continuous proximally with the popliteal fascia, and, a short distance distal to the knee on the medial side, it receives reinforcements of fibres from the tendons of the sartorius, gracilis, and semitendinosus. Distally, on the medial side, it is continuous with the ligamentum laciniatum (O.T. internal annular ligament), which crosses the interval between the medial malleolus and the calcaneus, and, on the lateral side, with the superior peroneal retinaculum which extends from the lateral malleolus to the calcaneus. On the medial side the deep fascia is attached to the medial border of the tibia, where it blends with the periosteum on the medial surface of that bone, and on the lateral side it joins the posterior fibular intermuscular septum, by which it is attached to the lateral crest of the fibula (Figs. 152, 155), thus it forms the posterior boundary of the great posterior osteo-fascial compartment of the leg.

Posterior Osteo-fascial Compartment of the Leg.—The posterior osteo-fascial compartment of the leg is bounded, posteriorly, by the deep fascia and, anteriorly, by the tibia, the interosseous membrane, and the fibula. It contains the muscles, vessels, and nerves of the back of the leg, and is divided into three portions by two fascial partitions which stretch across it. The first partition is attached, medially, to the popliteal line of the tibia (Fig. 152), and to the distal two-thirds of the medial border of the tibia, and, laterally, to the posterior surface of the fibula, below the attachment of the soleus, and to the lateral crest of the fibula (Fig. 152). Its upper portion forms a fibrous arch which covers the terminal part of the popliteal artery, and, in the distal part of the leg, it blends with and plays a very important part in the formation of the laciniate ligament. It separates the gastrocnemius, soleus, and plantaris, which lie in the posterior portion of the osteo-fascial compartment, from the flexor digitorum longus, the flexor hallucis longus, the tibial nerve and the posterior tibial artery and its branches which lie in the middle area.

The second septum, known as the fascia covering the tibialis posterior, is attached, medially, to the proximal part of the popliteal line of the tibia and to the vertical ridge on the posterior surface of the tibia and, laterally, to the medial crest of the fibula. Above, it blends with the interosseous membrane, and below it fuses with the deep surface of the first septum in the distal part of the leg. It separates the structures in the middle part of the osteo-fascial compartment from the tibialis posterior which occupies the anterior section of the compartment. Parts of the flexor hallucis longus and the flexor digitorum longus arise from its posterior surface, and fibres of the tibialis posterior spring from its anterior surface.

It follows, from what has been stated, that the great posterior osteo-fascial compartment of the leg is divided into three sections—posterior, middle, and anterior. The posterior section is bounded behind by the deep fascia of the leg and in front by the first septum. It contains the gastrocnemius, the soleus, the plantaris, which are called the superficial muscles of the calf, and the tendo calcaneus, which is the common tendon of insertion of the gastrocnemius and the soleus.

The middle section is bounded posteriorly by the first septum and anteriorly by the medial part of the tibia, the second septum, and the posterior surface of the fibula. It contains the long flexor of the toes, the long flexor of the great toe, the tibial nerve and its branches, and the posterior tibial vessels and their branches and tributaries.

The anterior section of the compartment is bounded posteriorly by the second fascial septum, and anteriorly by the tibia and the interosseous membrane. It contains the tibialis posterior muscle (Fig. 142).

Dissection.—The dissector must now proceed to the dissection of the contents of the three sections of the posterior osteo-fascial compartment, commencing with the superficial section.

First clean carefully the laciniate ligament, and secure the medial calcanean branches of the posterior tibial artery and of the tibial nerve which pierce it. Note that it is continuous proximally with the deep fascia of the posterior part of the leg, and that distally it gives attachment to the abductor hallucis; then make a longitudinal incision through the deep fascia, down the middle of the back of the leg, from the popliteal region proximally to the calcaneus distally. Turn the two flaps so defined to the medial and lateral sides respectively. Detach the distal end of the medial flap from the ligamentum laciniatum, but do not injure that ligament, and detach the distal end of the lateral flap from the superior peroneal retinaculum, but, if possible, avoid injury to the retinaculum. Note the attachment of the medial flap to the medial border of the tibia, and the connection of the lateral flap with the posterior fibular septum, by means of which attachment to the lateral crest of the fibula is attained (Figs. 152, 155).

When the connections of the deep fascia have been displayed, make an opening into the mucous sheath of the tendo calcaneus, at one or other border of the tendon, and, by inflation, injection or exploration with a blunt probe, attempt to demonstrate the extent of the sheath, which is somewhat variable. Next clean the gastrocnemius and the tendo calcaneus, and remove the thick pad of fat which lies in front of the tendo calcaneus, and separates it from the first fascial septum of the posterior compartment. Now examine the distal portion of the first fascial septum and note the important part it plays in binding down the muscles of the middle section of the compartment, and in the formation of the ligamentum laciniatum.

If the medial head of the gastrocnemius was not divided when the popliteal fossa was dissected, divide it now, at the level of the knee joint, and turn it laterally; then clean the sural arteries from the popliteal trunk, and the branches of the tibial nerve which supply the gastrocnemius. Raise the proximal part of the divided muscle, and note the bursa which intervenes between it and the semimembranosus. The bursa usually communicates with a bursa under cover of the semimembranosus which, in its turn, communicates with the cavity of the knee joint. Open the bursa and explore its extent with a blunt probe, if that has not already been done (see p. 309). Next follow the nerve to the soleus, which was found when the popliteal fossa was dissected (see p. 310). It springs from the tibial nerve in the popliteal fossa, on the medial side of the popliteal artery, crosses the posterior surface of the distal part of the artery, passes between the plantaris and the lateral head of the gastrocnemius, and enters the posterior surface of the soleus. When the nerve to the soleus has been cleaned and followed to its termination, clean the plantaris, and follow its slender tendon to its insertion into the posterior surface of the calcaneus on the medial side of the tendo calcaneus.

Superficial Muscles.—The superficial muscles of the calf of the leg are three in number, viz., the gastrocnemius, the plantaris, and the soleus. The gastrocnemius is the most superficial; the soleus is placed under cover of the gastrocnemius; whilst the slender plantaris extends distally and medially between them. The tendons of insertion of the gastrocnemius and soleus unite to form the tendo calcaneus (tendo Achillis).

M. Gastrocnemius.—The gastrocnemius is a strong muscle. It arises, by two heads, from the posterior part of the distal end of the femur. Both heads have been already studied in connection with the popliteal fossa, which they bound in its distal part. The *lateral head* springs from an impression on the lateral surface of the lateral condyle of the femur, and also from a small portion of the popliteal area of the bone, immediately proximal to the lateral condyle. The *medial head* takes origin from the proximal part of the medial condyle, and also from a rough ridge on the adjacent part of the popliteal surface of the femur. The two fleshy bellies swell out as they pass distally, and end, near the middle of the leg, in a thin aponeurotic tendon. They do not blend with each other, and are usually separated by a furrow, at the bottom of which the flattened tendon, to which the fasciculi of both heads are attached, may be seen. The medial head is the more bulky of the two, and it extends further distally than the lateral head. The flattened tendon in which they terminate narrows slightly as it descends, and, a short distance distal to the middle of the leg, it blends with the stouter tendon of the soleus to form the tendo calcaneus (tendo Achillis).

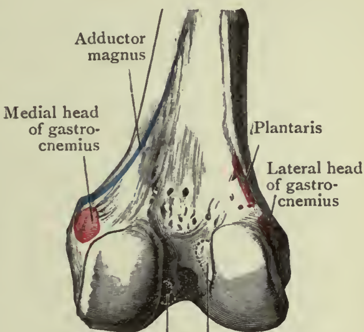


FIG. 162.—Posterior aspect of distal portion of Femur, with Attachments of Muscles mapped out.

The gastrocnemius is supplied by the *tibial nerve*. It is a plantar flexor of the foot and a flexor of the knee, but it cannot act efficiently both on the knee and the ankle joint at the same time. Therefore, if the foot is in the position of plantar flexion it cannot flex the knee, and if the knee is flexed it cannot act upon the ankle. It is important to remember these facts in association with fractures of the distal part of the femur.

M. Plantaris.—The small fleshy belly of the plantaris is not more than three or four inches long. It lies along the medial side, and partly under cover, of the lateral head of the gastrocnemius. It arises from the popliteal surface of the femur, immediately proximal to the lateral condyle. It ends in a slender tendon, which is remarkable for its great length. The tendon proceeds distally and medially, between the gastrocnemius and soleus, and then runs along the medial side of the tendo calcaneus (Achillis) to gain insertion into the posterior aspect of the calcaneus. It is frequently closely connected with the tendo calcaneus, and sometimes becomes blended with it, or with the fascia of the leg above the level of calcaneus.

The plantaris is supplied by a branch from the *tibial nerve.* Its actions are similar to those of the gastrocnemius.

Dissection.—Divide the lateral head of the gastrocnemius, at the level of the knee joint. Turn the proximal part upwards, and examine it to see if it contains a sesamoid bone which is sometimes present (Fig. 185); then look for a bursa which is occasionally present between it and the posterior part of the capsule of the knee joint. Turn the distal part downwards and note the manner in which the two heads join their thin aponeurotic tendon, and the union of the tendon with the tendon of the soleus to form the tendo calcaneus. Now clean the posterior surface of the soleus, note its origin from (1) the back of the head, and the proximal part of the posterior surface of the body of the fibula, (2) the fibrous arch over the distal end of the popliteal artery, (3) the oblique line of the tibia, and (4) the middle third of the medial border of the tibia. Note also the manner in which the majority of its fibres end in the strong tendon which blends with the tendon of the gastrocnemius to form the tendo calcaneus, whilst some of them pass directly to the deep surface of the tendo calcaneus.

M. Soleus.—The soleus is a flat, thick, and powerful muscle which arises from both bones of the leg, as well as from a strong fibrous arch which is thrown across the popliteal vessels. Its *fibular origin* is from the posterior surface of the head and the proximal third of the posterior surface of the body of the bone; by its *tibial origin* it is attached to the linea poplitea of the tibia, distal to the popliteal surface, and, more distally, to the medial border of the bone as far as the middle of the leg (Fig. 166, p. 376). The soleus ends in a strong, stout tendon which joins with the tendon of the gastrocnemius to form the tendo calcaneus (Achillis). Branches from the *tibial nerve* supply the soleus. It is a plantar flexor of the foot.

Tendo Calcaneus (Achillis).—This is the most powerful tendon in the body. It narrows as it descends, but near the heel it again expands slightly. It is inserted into the middle portion of the posterior surface of the calcaneus. The fleshy fibres of the soleus are continued distally on its deep surface to within a short distance of the heel. A mucous bursa intervenes between the tendo calcaneus and the proximal part of the posterior surface of the calcaneus.

Dissection.—Divide the soleus muscle along its line of origin from the tibia and separate it from the fibrous arch over the vessels and the tibial nerve; then turn it to the lateral side and secure the branches which the muscle receives from the peroneal and posterior tibial arteries.

The first fascial septum which stretches across the posterior osteo-fascial compartment is now fully exposed. Note its attachments to the tibia and fibula (see p. 367), and its continuity, distally, with the laciniate ligament. Separate it carefully from the laciniate ligament, but do not injure the ligament; then divide it longitudinally along the middle line of the leg and turn the two pieces, one medially and the other laterally. The middle section of the posterior osteo-fascial compartment is now opened up and two muscles, the tibial nerve, the termination of the popliteal artery, the commencements of the anterior and posterior tibial arteries are exposed, the vessels and the nerve being embedded in some loose areolar tissue. The muscle on the medial side is the long flexor of the toes, the muscle on the lateral side is the long flexor of the great toe. In the distal part of the leg, emerging from under cover of the medial border of the tendon of the long flexor of the toes, the tendon of the tibialis posterior will be seen. Clean first the tibial nerve and secure the branches which it gives to the flexor digitorum longus, the flexor hallucis longus, and the tibialis posterior; they arise as a rule in the upper part of the leg. Next clean the termination of the popliteal artery, the first part of the anterior tibial artery and its fibular and posterior tibial recurrent branches, then the posterior tibial vessels and their branches and tributaries. The peroneal branch of the posterior tibial artery arises about 25 mm. distal to the commencement of the parent trunk, and immediately proximal to the point where the tibial nerve crosses posterior to the posterior tibial artery. It soon disappears under cover of the flexor hallucis longus; do not trace it at present beyond the point of disappearance. After the nerve and vessels are displayed clean first the flexor digitorum longus and then the flexor hallucis longus. When that has been done separate the two muscles and push the flexor hallucis longus laterally, separating its deep surface from the posterior surface of the second fascial septum of the posterior osteo-fascial compartment, and from the distal part of the interosseous membrane, to both of which it is attached. As the fibula is approached the peroneal branch of the posterior tibial artery will be found descending between the flexor hallucis longus and the posterior surface of the second fascial septum, which separates it from the tibialis posterior. Trace the artery distally. Below the level of the origin of the tibialis posterior it lies on the posterior surface of the interosseous membrane, and immediately above the distal tibio-fibular joint it gives off the perforating branch, which was seen in the dissection of the dorsum of the foot (p. 350). Now pull the distal part of the flexor hallucis longus medially and follow the distal part of the peroneal artery behind the ankle joint and along the medial side of the peronæi tendons to the lateral side of the calcaneus. In order to expose its terminal branches the peroneal retinacula must be divided, and it may be necessary to displace the peroneal tendons.

Termination of the Popliteal Artery.—The termination of the popliteal artery, which was concealed by the proximal border of the soleus, is now fully exposed. It ends at the distal border of the popliteus, where it divides into its two terminal branches, the anterior and posterior tibial arteries. At the same point the venæ comites of the anterior and posterior tibial arteries join to form the commencement of the popliteal vein.

Arteria Tibialis Anterior.—The anterior tibial artery passes forwards, between the two heads of the tibialis posterior muscle, to the anterior region of the leg, where it has already been dissected. Whilst still in the back of the leg the anterior tibial artery gives off a posterior recurrent tibial and a fibular branch. The *posterior tibial recurrent* is a small twig which is not always present. It runs proximally, under cover of the popliteus muscle, to the back of the knee joint. The *fibular branch* runs laterally, on the neck of the fibula, and is distributed to the muscles and integument in that neighbourhood.

Arteria Tibialis Posterior.—The posterior tibial artery is the larger of the two terminal branches of the popliteal trunk. It takes origin at the distal border of the popliteus muscle and ends, by dividing into the lateral and medial plantar arteries in the hollow on the medial side of the calcaneus, under cover of the ligamentum laciniatum. In the first instance the artery is placed, between the two bones of the leg, upon the fascia covering the posterior surface of the tibialis posterior muscle; but, as it passes distally it inclines gradually medially,

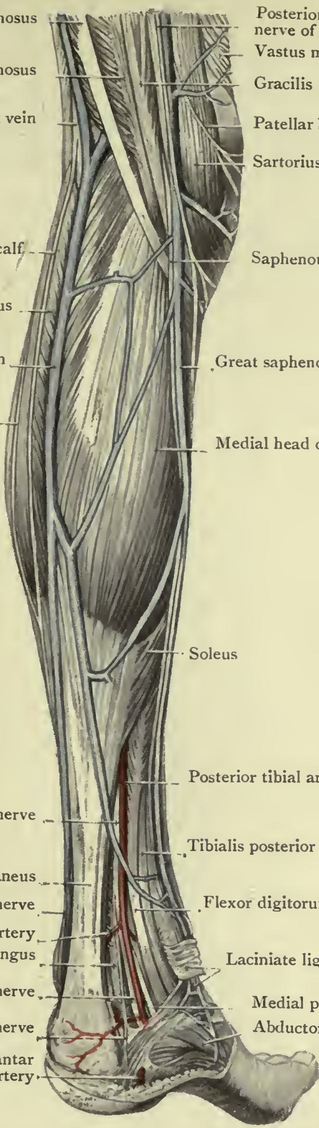


FIG. 163.—Dissection of the Posterior Aspect of the Leg viewed from behind and medially.

Note the numerous anastomoses between the great and the small saphenous veins.

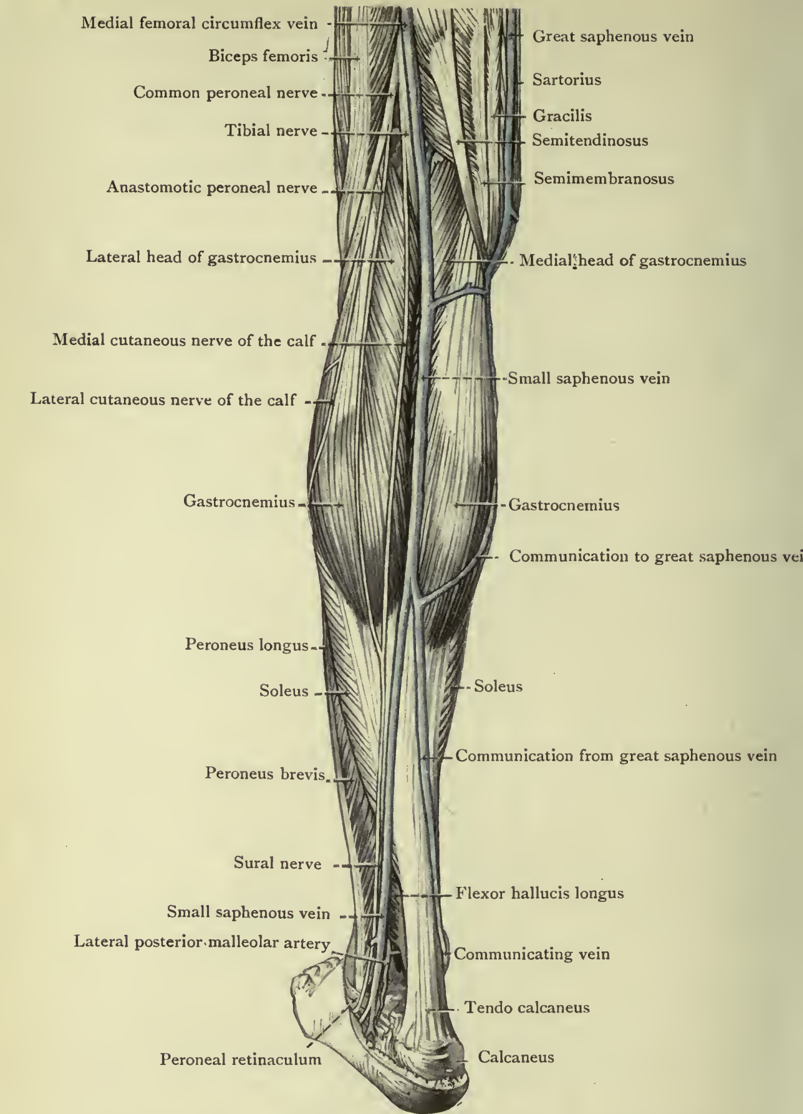


FIG. 164.—Dissection of the Posterior Aspect of the Leg viewed from behind and laterally.

In the specimen there were numerous large anastomosing channels between the small and the great saphenous vein.

and at its termination it lies midway between the prominence of the calcaneus and the medial malleolus.

In its proximal two-thirds the posterior tibial artery is situated deeply, being covered by the superficial muscles of the calf. In the distal third of the leg, where it lies between the tendo calcaneus and the medial border of the tibia, it is relatively superficial and is covered merely by the integument and two layers of fascia. More distally it is covered by the ligamentum laciniatum. Proximo-distally it rests against the fascia on the tibialis posterior, the flexor digitorum longus, the tibia, and the posterior aspect of the ankle joint (Fig. 163).

Throughout its entire course the posterior tibial artery is closely accompanied by two *venæ comites.* The *tibial nerve* is at first on its medial side, but it soon crosses behind the vessel, and then proceeds distally on its lateral side.

The following are the branches which issue from the posterior tibial artery:—

1. Rami musculares.
2. Rami cutanei.
3. A. nutricia tibiæ.
4. A. peronæa.
5. Rami calcanei mediales.
6. Ramus communicans.
7. A. plantaris medialis.
8. A. plantaris lateralis.

Arteria Peronæa.—Although the *peroneal artery* is not the first it is, as a rule, the largest branch of the posterior tibial. It arises about 25 mm. or so distal to the commencement of the parent trunk, and at first runs, obliquely distally, and laterally, to the fibula. In this first part of its course it rests against the fascia covering the tibialis posterior and it is covered by the soleus; then it descends along the medial crest of the fibula, covered by the flexor hallucis longus and lying first, against the fascia covering the tibialis posterior, and next, against the interosseous membrane. Immediately above the ankle joint it emerges from under cover of the flexor hallucis longus, passes behind the distal tibio-fibular joint and the ankle joint, medial to the peronæi tendons, and it breaks up on the lateral aspect of the calcaneus into a number of lateral calcanean branches.

The branches of the peroneal artery are: (1) muscular branches to the adjacent muscles; (2) a nutrient branch to the fibula; (3) the perforating branch which pierces the interosseous membrane near the distal tibio-fibular joint, and has already been dissected on the dorsum of the foot (see

p. 305); (4) a communicating branch, which springs from the

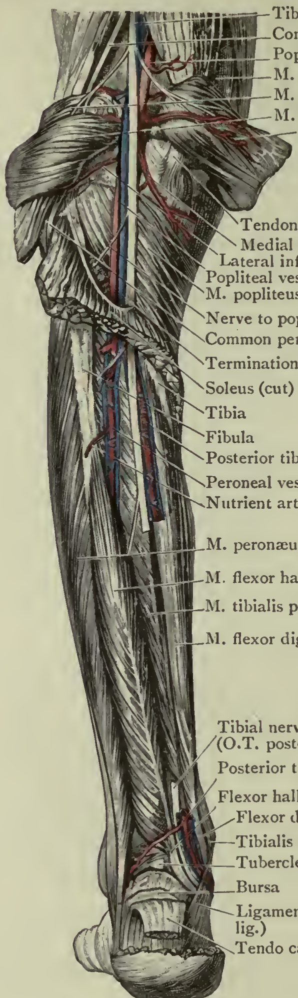


FIG. 165.—Deep Dissection of the Back of the Leg.

medial side of the peroneal artery about one inch proximal to the distal end of the tibia, and passes medially, anterior or posterior to flexor hallucis longus, to join the posterior tibial artery; (5) the terminal lateral calcanean branches.

The peroneal artery is sometimes as large as the continuation of the posterior tibial artery beyond the point of origin of the peroneal. In such cases the perforating branch may be large, and may partially or entirely replace the dorsalis pedis artery, or the communicating branch to the posterior tibial artery may be large.

The peroneal artery is accompanied by venæ comites, and, in the proximal part of its extent, it is also accompanied by the nerve to the flexor hallucis longus.

The *nutrient artery* springs from the posterior tibial close to its origin, and, after giving some twigs to muscles, enters the nutrient foramen of the tibia. It is remarkable on account of its large size.

The *muscular branches* supply the deep muscles on the back of the leg, and one or two of large size enter the soleus.

The *cutaneous branches* are given to the skin on the medial aspect of the leg.

The *communicating branch* is given off about an inch proximal to the distal end of the tibia. It passes transversely laterally, under cover of the flexor hallucis longus or superficial to it, and joins the peroneal artery (Figs. 163, 164, 165).

The *medial calcanean branches* pierce the ligamentum laciniatum, and accompany the nerves of the same name to the skin of the heel and the sole.

Crural Part of Nervus Tibialis (O.T. **Posterior Tibial Nerve**).—The tibial nerve is continued from the popliteal fossa through the posterior region of the leg to the hollow between the heel and the medial malleolus, where it divides into the lateral and medial plantar nerves. The division takes place proximal to the division of the posterior tibial artery. The nerve accompanies the posterior tibial vessels, and presents the same relations. For a short distance, in the proximal part of the leg, it lies on the medial side of the posterior tibial artery, but it soon crosses superficial to the artery, and is then continued distally, and, for the remainder of its course, lies on the lateral side of the vessel.

It supplies—(*a*) *muscular branches* to the tibialis posterior, flexor hallucis longus, flexor digitorum longus, and soleus; (*b*) *cutaneous twigs*—the *medial calcanean branches*—which spring from it close to its termination, and pierce the ligamentum

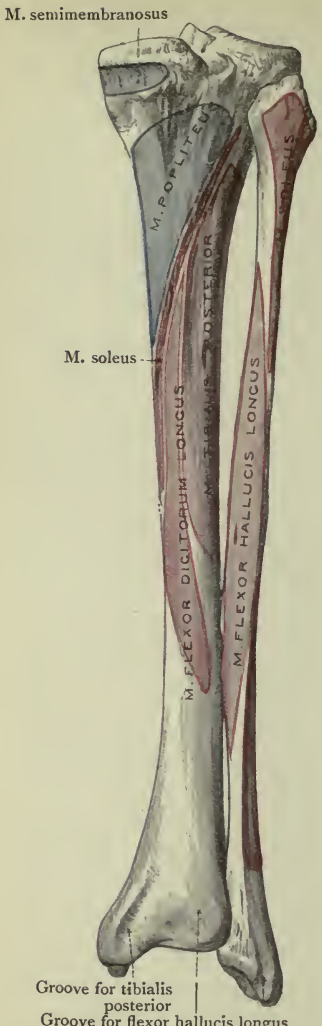


FIG. 166. — Posterior aspect of Bones of Leg with Attachments of Muscles mapped out.

laciniatum to reach the integument of the heel and sole of the foot; and (*c*) *articular filaments* to the ankle joint.

Deep Muscles.—The *popliteus muscle* will be seen lying upon the posterior aspect of the knee joint and upon the posterior surface of the tibia proximal to the linea poplitea. Its tendon of origin lies within the capsule of the knee joint, and cannot be properly studied until that articulation is dissected.

Note the strong fascia which covers the posterior surface of the popliteus, and trace it proximally and medially to the medial side of the knee. There it becomes continuous with the tendon of the semimembranosus, and through it, therefore, the semimembranosus may be regarded as having an insertion into the linea poplitea of the tibia.

The *flexor hallucis longus* is placed upon the posterior aspect of the fibula, and its tendon will be noticed grooving the posterior border of the talus as it passes distally and forwards to gain the sole of the foot. The *flexor digitorum longus* lies upon the tibia. The *tibialis posterior* rests upon the interosseous membrane and between the fleshy bellies of the two flexors but upon a deeper plane.

M. Popliteus.—The popliteus muscle arises by a stout narrow tendon, within the capsule of the knee joint, from the anterior part of the popliteal groove on the lateral surface of the lateral condyle of the femur. The tendon pierces the posterior part of the capsule of the knee joint, and the fleshy fibres which arise from it are directed medially and distally, and spread out to obtain insertion into the posterior surface of the tibia proximal to the linea poplitea, and also into the fascia which covers the muscle.

The nerve to the popliteus has already been seen to arise from the *tibial nerve.* It can now be seen hooking round the distal margin of the muscle to reach its anterior surface. The popliteus is a flexor of the knee and a medial rotator of the leg.

M. Flexor Hallucis Longus.—The long flexor of the great toe is a powerful muscle which arises from the posterior surface of the fibula, distal to the origin of the soleus, from the posterior fibular septum, and from the surface of the fascia covering the tibialis posterior. After passing behind the ankle joint its tendon occupies a deep groove on the posterior border of the talus, then it turns forwards under cover of the ligamentum laciniatum to gain the sole of the foot. The flexor hallucis longus is supplied by the *tibial nerve.* It is a flexor of the interphalangeal and metatarso-phalangeal joints of the great toe, a plantar flexor of the foot, and it assists in producing inversion of the foot.

M. Flexor Digitorum Longus.—The flexor digitorum longus arises from the posterior surface of the body of the tibia, distal to the popliteus, and medial to the vertical ridge which descends from the linea poplitea. It also derives fibres from the surface of the fascia which covers the tibialis posterior. After crossing superficial to the distal part of the tibialis posterior, its tendon grooves the back of the medial malleolus on the lateral side of the tendon of the tibialis posterior. It is continued under cover of the ligament laciniatum into the sole of the foot. The flexor digitorum longus is supplied by the *tibial nerve.* It is a flexor of the interphalangeal and metatarso-phalangeal joints of the lateral four toes, and it assists in producing plantar flexion and inversion of the foot.

M. Tibialis Posterior (O.T. Tibialis Posticus).—The tibialis posterior takes origin from the posterior surface of the interosseous membrane, from the posterior part of the medial surface of the body of the fibula, from the posterior surface of the body of the tibia, on the lateral side of the flexor digitorum longus, and from the fascia which covers it. In Fig. 152, p. 340, the compartment which it occupies is shown in a diagrammatic manner, and the surfaces from which it takes origin are indicated. Towards the distal part of the leg the tibialis posterior inclines medially, under cover of the flexor digitorum longus, and its strong flattened tendon grooves the back of the medial malleolus to the medial side of the tendon of that muscle. Proceeding under cover of the ligamentum laciniatum, its tendon is

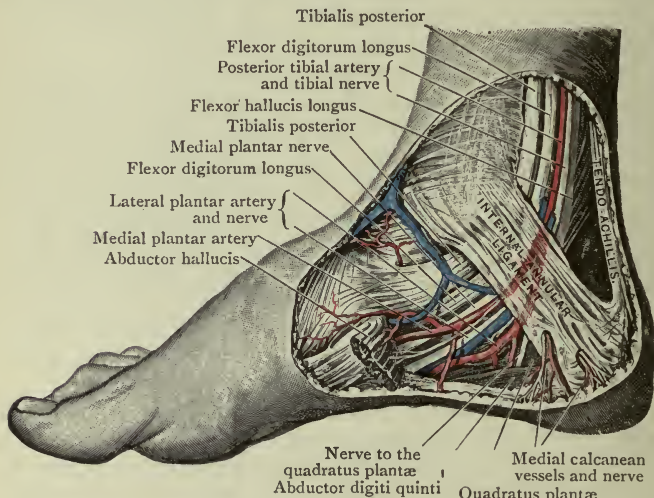


FIG. 167.—Dissection of the medial side of the Ankle, showing the relations of the lig. laciniatum (O.T. internal annular lig.).

inserted into the tubercle of the navicular bone, and also, by a number of slips, into certain of the tarsal and metatarsal bones. Those slips will be dissected later. The tibialis posterior is supplied by the *tibial nerve.* It is a plantar flexor and an invertor of the foot.

Ligamentum Laciniatum.—The connections of this thickened band of the deep fascia should now be carefully re-examined. It bridges across the hollow between the medial malleolus and the medial prominence of the calcaneus, and is attached to both. It has already been shown that its proximal border is continuous not only with the deep fascia covering the superficial muscles of the calf but also with the septum which separates those muscles from the deeper muscles of the leg (see p. 367), and it has been pointed out that the septum takes a more important part in the formation of the ligament than the more superficial layer of deep fascia. Its distal or anterior margin is continuous with the medial part of the plantar aponeurosis, and it gives attachment to the abductor hallucis muscle which is subjacent to that aponeurosis. It is pierced by the medial calcanean branches of the posterior tibial artery and the tibial nerve, and by a communicating vein which connects the great saphenous vein with the venæ comites of the posterior tibial artery.

The dissector should note that under cover of the ligament lie (1) the termination of the posterior tibial artery and the commencement of its two terminal branches, the medial and lateral plantar arteries, with their accompanying veins; (2) the distal part of the posterior tibial nerve and its medial and lateral plantar terminal branches; (3) the tendon of the tibialis posterior; (4) the tendon of the flexor digitorum longus; (5) the tendon of the flexor hallucis longus. From the medial to the lateral side the structures lie in the following order:—

1. Tendon of tibialis posterior.
2. Tendon of flexor digitorum longus.
3. Posterior tibial vessels.
4. Tibial nerve.
5. Tendon of flexor hallucis longus.

The tendons are isolated from one another, and from the vessels and nerve, by septa which pass from the deep surface of the ligament to ridges on the adjacent bones. The septa can be demonstrated by slitting open the ligament for a short distance along the line of each tendon. Each of the three compartments will then be seen to be lined with a glistening mucous sheath, and the dissector should investigate the extent of each sheath as far as possible, with the aid of a blunt probe, for as the sheaths have been freely opened it will not be possible to inflate or inject them. The sheaths end proximally about 25 mm. above the medial malleolus. Distally the sheath of the tibialis posterior reaches to the insertion of the tendon into the tubercle of the navicular bone. The sheath of the flexor digitorum longus extends to about the middle of the length of the foot, and that of the flexor hallucis longus can be traced, under favourable circumstances as far as the middle of the metatarsal bone of the great toe (Fig. 168).

Anastomosis around the Ankle Joint.—The dissector should next satisfy himself with regard to the anastomosis of arteries which takes place around the ankle joint. On the *lateral aspect* of the joint he will observe inosculations taking

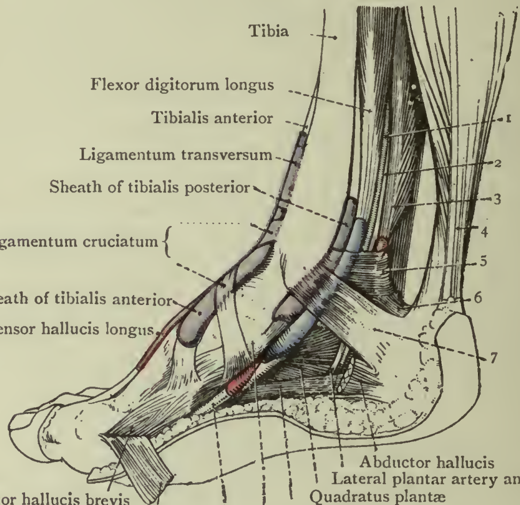


FIG. 168.—Dissection of Leg and Foot showing Mucous Sheaths of Tendons.

1. Arteria tibialis posterior.
2. Nervus tibialis.
3. Flexor hallucis longus.
4. Tendo calcaneus
5. First intermuscular septum of posterior crural region taking part in the formation of the ligamentum laciniatum.
6. Calcaneus.
7. Ligamentum laciniatum.

place between branches of the following arteries:—(*a*) lateral malleolar; (*b*) perforating branch of peroneal; (*c*) terminal part of peroneal; and (*d*) lateral tarsal.

On the *medial aspect* of the joint the medial malleolar branch of the anterior tibial anastomoses with small twigs from the medial calcanean branches of the posterior tibial.

SOLE OF THE FOOT.

In this dissection the dissector will meet with the following structures:—

1. Superficial fascia and cutaneous vessels and nerves.
2. Plantar aponeurosis.
3. Superficial muscles, { Abductor hallucis. Flexor digitorum brevis. Abductor digiti quinti.
4. Lateral and medial plantar vessels.
5. Lateral and medial plantar nerves.
6. Tendons of flexor hallucis longus and flexor digitorum longus.
7. Quadratus plantæ and lumbrical muscles.
8. Flexor hallucis brevis. Adductor hallucis, transverse and oblique heads.
9. Flexor brevis digiti quinti.
10. Plantar arterial arch.
11. Plantar metatarsal arteries.
12. Plantar digital arteries.
13. Tendons of peronæus longus and tibialis posterior.
14. Interosseous muscles.

Before commencing the dissection of the sole of the foot the dissector should note the thickness of the skin over the heel, on the balls of the toes, which correspond with the heads of the metatarsal bones, and, to a less extent, along the lateral border of the foot, on all of which parts the weight of the body presses in the erect posture. Other noticeable features are the relative shortness of the toes as contrasted with the length of the fingers, and the fact that the longest digit of the foot is either the second or the first, and not, as in the case of the hand, the middle digit.

Dissection.—Reflection of Skin.—The limb should be placed upon the table, with the sole of the foot facing the dissector, and the ankle supported by a good-sized block. Two incisions are required—(1) a longitudinal incision along the middle line of the sole, from the heel to the root of the middle toe; (2) a transverse cut, at the digital extremity of the median incision, across the sole at the roots of the toes. The skin should also be reflected from the plantar surface of each of the toes. This can be done after a longitudinal incision has been made along its middle line.

Superficial Fascia.—When the flaps of skin mapped out are reflected, the peculiar character of superficial fascia becomes apparent. Along the lateral border of the foot, over the heads of the metatarsal bones, and in the region of the heel, it is thick. It is tough and granular, and in some respects resembles the superficial fascia which covers the ischial tuberosity. Traversing it are tough fibrous

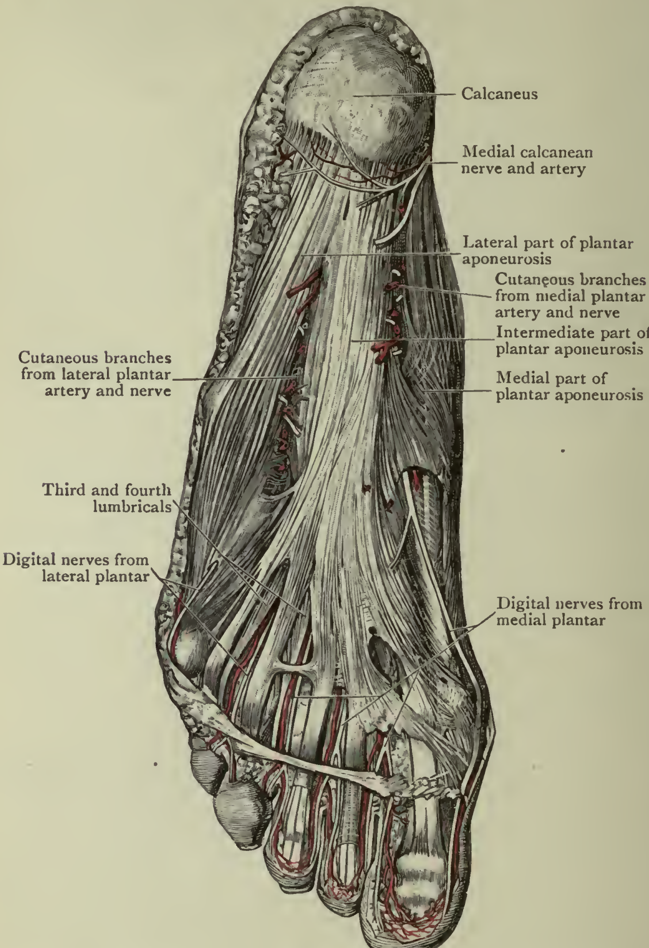


FIG. 169.—Superficial Dissection of the Sole of the Foot ; the Skin and Superficial Fascia alone removed.

bands, which subdivide the fatty tissue into small lobules, and connect the thick skin of the sole with the plantar aponeurosis.

Dissection.—The *medial calcanean nerves*, which have already been found piercing the ligamentum laciniatum, should be traced to their distribution. They supply the skin of the sole in the neighbourhood of the heel, and are accompanied by ramifications of the medial calcanean branches of the posterior tibial and lateral plantar arteries.

The superficial fascia may now be removed. Divide it along the middle line of the sole, and turn it laterally and medially, cleaning at the same time the plantar aponeurosis. As the dissector approaches the lateral and medial margins of the foot respectively, he will note, on each side, a furrow; the furrows extend forwards at the sides of the intermediate part of the plantar aponeurosis. Along the furrows a number of blood-vessels and some nerves will be seen piercing the deep fascia in order to reach the skin. Towards the intervals between the heads of the metatarsal bones the metatarsal arteries and the plantar digital nerves are unprotected by the aponeurosis, and the dissector must proceed cautiously. The nerves and vessels which go to the medial side of the great toe and to the fibular side of the little toe are especially liable to injury, as they perforate the aponeurosis farther back than the others. A band of transverse fibres, which crosses the roots of the toes and lies over the digital vessels and nerves, should be noticed. It is the *superficial transverse ligament* of the toes, and is closely connected with the skin where that forms the cutaneous webs between the toes. By forcibly separating the toes its connections will become evident. When the relations of the ligament have been studied it may be removed.

Aponeurosis Plantaris (O.T. Plantar Fascia).—The plantar aponeurosis, which is now brought into view, consists of three portions—(*a*) a medial, (*b*) an intermediate, and (*c*) a lateral part. The subdivision is indicated by a difference in the density of the three parts and by two shallow furrows which traverse the foot in a longitudinal direction, one upon each side of the strong intermediate portion of the aponeurosis. Each of the three portions is in relation to a subjacent muscle. The *intermediate portion* covers the flexor digitorum brevis; the *lateral part* clothes the abductor digiti quinti; and the *medial part* covers the abductor hallucis.

The *intermediate portion* of the plantar aponeurosis stands out in marked contrast to the lateral and medial portions in point of strength and density. Posteriorly, where it is attached to the medial process of the calcaneus, it is narrow, but it expands as it passes forwards, and, near the heads of the metatarsal bones, splits into five processes, which are bound together by transverse fibres. In the intervals between the digital slips the metatarsal vessels, the digital nerves, and the lumbrical muscles appear. Trace the processes forwards. One goes to the root of each toe;

there it divides into two slips. The two slips embrace the flexor tendons of the toe, and become fixed to the flexor sheaths, and to the transverse ligament of the heads of the metatarsal bones. The general characters, therefore, of the intermediate part of the plantar aponeurosis closely resemble those of the intermediate part of the palmar aponeurosis.

The *lateral and medial parts* of the plantar aponeurosis are weak, in comparison with the intermediate portion. They merely constitute fascial coverings for the muscles which lie subjacent. A strong band is to be noted in connection with the *lateral part*. It stretches between the prominence formed by the base of the fifth metatarsal bone and the lateral process of the tubercle of the calcaneus.

In connection with the plantar aponeurosis two *intermuscular septa* also have to be studied. These pass dorsally into the sole, along the lines of the longitudinal furrows which mark off the intermediate from the medial and lateral parts of the aponeurosis. They consequently lie one upon each side of the flexor digitorum brevis, and form partitions which separate it from the abductor hallucis on the one side, and the abductor digiti quinti on the other.

> ***Dissection.***—To demonstrate the above-mentioned septa, make a transverse incision through the intermediate portion of the plantar aponeurosis, about an inch in front of the medial process of the tubercle of the calcaneus, and also a longitudinal cut through the same piece of aponeurosis, extending from the first incision along the middle line of the foot. Now raise the divided aponeurosis and throw it laterally and medially. Some difficulty will be experienced owing to the deep surface of the aponeurosis affording origin, in its posterior part, to the subjacent flexor digitorum brevis. As the margins of this muscle are approached the septa are brought into view. As the anterior part of the divided aponeurosis is reflected, care must be taken to avoid injury to the plantar digital arteries and nerves which lie close to the deep surface of the aponeurosis.

Muscles and Tendons of the Sole.—It is customary to look upon the muscles and tendons found in the dissection of the sole as being disposed in four strata, in or between which lie the plantar vessels and nerves and their branches, whilst the layers themselves are separated from one another by fibrous partitions, viz. :—

First layer.	Abductor hallucis. Flexor digitorum brevis. Abductor digiti quinti.

Second layer.	Tendon of flexor digitorum longus. Quadratus plantæ. Lumbrical muscles. Tendon of flexor hallucis longus.
Third layer.	Flexor hallucis brevis. Adductor hallucis, oblique and transverse heads. Flexor digiti quinti brevis.
Fourth layer.	Interosseous muscles. Tendon of peronæus longus. Tendon of tibialis posterior.

Dissection.—Separate the lateral and medial portions of the plantar aponeurosis from the subjacent muscles. Whilst that is being done great care must be taken to avoid injury to the digital branch from the lateral plantar nerve to the lateral side of the little toe, and the digital branch of the medial plantar nerve and the digital artery to the medial side of the great toe. To avoid injuring those structures seize a reflected portion of the intermediate part of the plantar aponeurosis and cut, horizontally through the septum which dips deeply from it at the side of the flexor digitorum brevis, lateral or medial side as the case may be, then keep the edge of the scalpel playing closely against the deep part of the aponeurosis from which the septum springs. Difficulty will be experienced in the posterior part of the foot, where the deep surface of each piece of the aponeurosis gives origin to fibres of the subjacent muscle. The muscular fibres must be detached and the posterior ends of the two pieces of aponeurosis must be separated from the calcaneus.

When the reflection of the medial and lateral parts of the aponeurosis is completed the following structures are exposed. Medially, the abductor hallucis and the digital artery and nerve to the medial side of the great toe. Laterally, the abductor digiti quinti and the digital artery and nerve to the lateral side of the little toe. In the intermediate area, the flexor digitorum brevis and its four terminal tendons, and the tendon of the flexor hallucis longus will be found, with the digital vessels and nerves and the lumbrical muscles in the intervals between the flexor tendons; whilst deep to the tendon of the flexor hallucis longus, part of the flexor hallucis brevis is visible, and between the abductor digiti quinti and the flexor digitorum brevis the flexor digiti quinti brevis and the interossei in the fourth space can be seen.

When the structures mentioned have been identified cut down into the posterior part of the interval between the abductor hallucis and the flexor digitorum brevis, immediately in front of the medial process of the calcaneus, and secure the posterior parts of the medial and lateral plantar nerves and arteries; then follow the medial plantar nerve forwards and secure first the branches which it gives to the abductor hallucis and the flexor digitorum brevis, and then its four terminal digital branches. As the first digital branch, that to the medial side of the great toe, is followed it will be found to give a twig to the flexor hallucis brevis, whilst the second digital branch, which supplies the adjacent sides of the first and second toes, gives a twig to the first lumbrical muscle, and the fourth digital branch is connected by a communicating strand with the medial digital branch of the lateral plantar nerve.

The trunk and branches of the relatively small medial plantar artery accompany the trunk and branches of the medial plantar nerve, and must be cleaned as the nerve and its branches are dissected out of the surrounding fascia.

When the medial plantar vessels and nerves have been displayed, cut down into the interval between the flexor digitorum brevis and the abductor digiti quinti, behind the projecting base of the metatarsal bone of the fifth toe, and secure the trunk of the lateral plantar nerve, before it divides into its superficial and deep divisions, and the accompanying lateral plantar artery which lies lateral to the nerve. As the nerve passes forwards it divides into a superficial and a deep branch, at the level of the base of the fifth metatarsal bone and, at the same level, the lateral plantar artery, accompanied by the deep branch of the nerve, turns medially and deeply to become the *plantar arterial arch.* Follow the superficial division of the nerve forwards, and secure (1) the muscular branches which it gives to the flexor digiti quinti brevis, and the interossei of the fourth interosseous space; (2) its two digital branches, one to the lateral side of the little toe, and one which divides to supply the adjacent sides of the fourth and fifth toes; the latter is connected, by a communicating twig, with the fourth digital branch of the medial plantar nerve. Clean also the arteries which accompany the nerves. Now divide the muscular belly of the flexor digitorum brevis, transversely, at the middle of its length; turn the posterior part backwards, and define its attachments to the medial and lateral processes of the calcaneus; throw the anterior part forwards towards the toes where its tendons enter the flexor sheaths, which will be examined later. Next detach the abductor hallucis from the medial process of the calcaneus, but not from the laciniate ligament, and turn it medially. The structures now exposed are—(1) the first parts of the lateral plantar vessels and nerve, and their branches; (2) deep to the vessels and nerve, the quadratus plantæ; (3) posteriorly, between the two heads of the quadratus plantæ, the posterior part of the long plantar ligament; (4) medial to the quadratus plantæ the tendon of the flexor digitorum longus dividing, anteriorly, into four slips from which the lumbrical muscles arise; (5) medial to the flexor longus digitorum a further portion of the tendon of the flexor hallucis longus lying between the two heads of the flexor hallucis brevis (Figs. 170, 171).

Clean, first, the lateral plantar nerve and its muscular branches. The first branch is the branch to the abductor digiti quinti. It lies far back, close to the processes of the calcaneus. The branch to the quadratus plantæ is a little further forward. In addition there are a number of cutaneous branches which become superficial along the interval between the abductor digiti quinti and the flexor digitorum brevis. Next clean the lateral plantar artery and follow its medial calcanean branch to the posterior part of the interval between the flexor digitorum brevis and the abductor hallucis where it becomes superficial. It is distributed to the fat and skin of the heel. After the vessels and nerves are cleaned clean the muscles and tendons.

M. Flexor Digitorum Brevis.—The short flexor of the toes arises from the medial process of the calcaneus, from

PLATE XXXIV

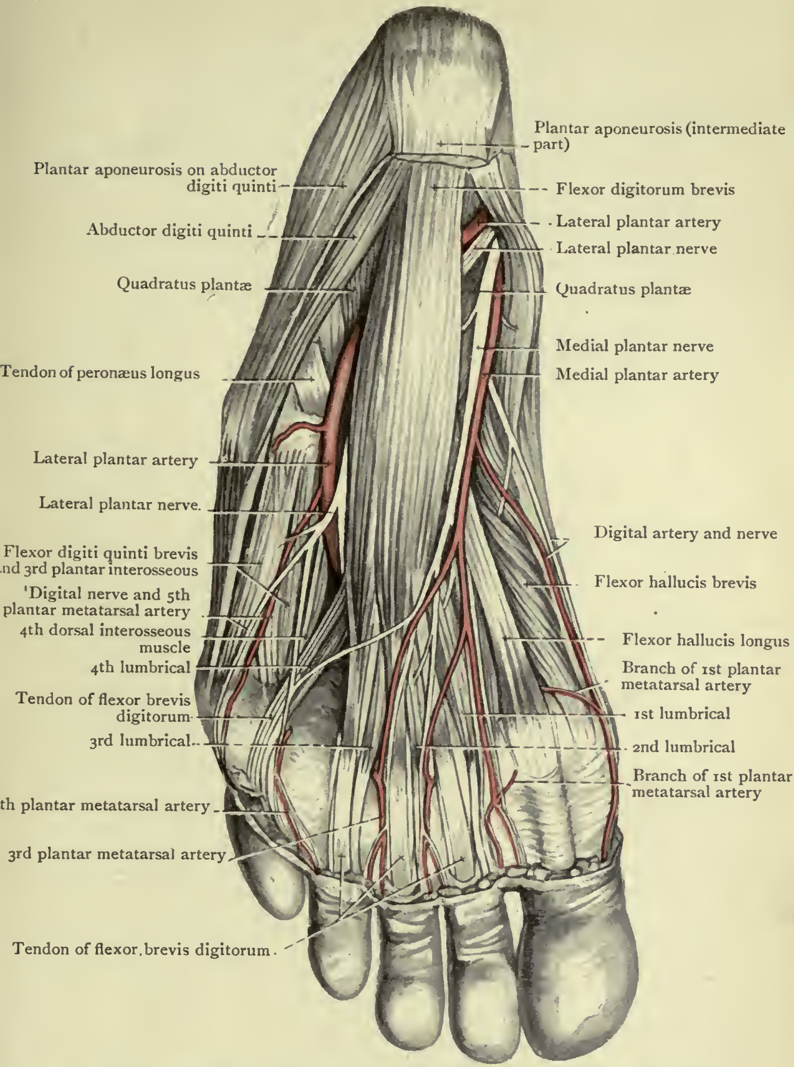


FIG. 170.—Superficial dissection of the Sole of the Foot. The plantar aponeurosis has been removed. The abductor digiti quinti and the abductor hallucis have been pulled aside.

the deep surface of the intermediate part of the plantar aponeurosis, and from the intermuscular septum on each side of it. About the middle of the sole the fleshy belly divides into four slips, which end in slender tendons for the lateral four toes. The tendons enter the fibrous flexor sheaths of the toes, and will be afterwards studied. The flexor digitorum brevis is supplied by the *medial plantar nerve*. It is a flexor of the first interphalangeal joints and the metatarso-phalangeal joints of the lateral four toes.

M. Abductor Hallucis.—The abductor of the great toe takes origin from the medial aspect of the medial process of the tubercle of the calcaneus, from the medial intermuscular septum, from the distal border of the ligamentum laciniatum, and from the medial part of the plantar aponeurosis, which covers it. A strong tendon issues from the fleshy belly. This is joined, on its lateral and deep surface, by fibres of the medial head of the flexor hallucis brevis, and it is inserted into the medial aspect of the base of the proximal phalanx of the great toe. The abductor hallucis is supplied by the *medial plantar nerve*. It abducts the great toe from the middle line of the second toe.

M. Abductor Digiti Quinti (O.T. **Abductor Minimi Digiti**).—The origin of the abductor of the little toe extends medially under cover of the flexor digitorum brevis. The posterior part of the latter muscle which has already been divided must, therefore, be turned well backwards to expose the medial part of the origin of the abductor of the little toe. The abductor digiti quinti is then seen to have a broad origin from both the medial and lateral processes of the calcaneus. It also arises from the lateral intermuscular septum, and the lateral part of the plantar aponeurosis, which covers it. Its tendon is inserted into the lateral aspect of the base of the first phalanx of the little toe. The abductor digiti quinti is supplied by the *lateral plantar nerve*. It abducts the little toe from the middle line of the second toe.

Dissection.—The abductor hallucis has already been separated from the medial side of the medial process of the calcaneus. Separate it now from the distal border of the laciniate ligament, and turn it medially; then divide the laciniate ligament until the origins of the plantar arteries and nerves are exposed. They are the terminal branches of the posterior tibial artery and the tibial nerve, and they arise in the distal part of the leg under cover of the proximal part of the laciniate ligament.

Art. Plantaris Medialis (O.T. Internal Plantar Artery).—The medial plantar artery is the smaller of the two terminal branches of the posterior tibial artery. It arises in the hollow between the medial malleolus and the prominence of the calcaneus, under cover of the ligamentum laciniatum. At the distal border of the ligamentum laciniatum it passes under cover of the abductor hallucis; but, as it proceeds forwards, it appears in the interval between that muscle and the flexor digitorum brevis. Finally, at the root of the great toe, it ends by joining the plantar metatarsal artery to the medial side of the hallux.

The *branches* which proceed from the medial plantar artery are small but very numerous. They are—(1) three twigs which accompany the digital branches of the medial plantar nerve to the clefts between the medial four toes—they end by joining the metatarsal branches of the plantar arch; (2) a series of cutaneous branches to the skin of the sole, which pierce the aponeurosis in the furrow between its medial and intermediate parts; (3) a number of branches to the muscles in the vicinity; (4) some offsets which pass medially under cover of the abductor hallucis to reach the medial border of the foot.

Art. Plantaris Lateralis (O.T. External Plantar Artery).—The lateral plantar artery is much larger than the medial plantar. It is accompanied by the lateral plantar nerve and two *venæ comites*. From its origin in the hollow of the calcaneus, under cover of the laciniate ligament, it passes laterally, across the sole, to reach the interval between the flexor digitorum brevis and the abductor digiti quinti. In that interval it is continued forwards for a short distance, and then, at the level of the base of the fifth metatarsal bone, it turns suddenly to the medial side, and crosses the sole a second time, under cover of the flexor tendons and the adductor hallucis, forming the plantar arch. In the present stage of the dissection it is displayed only as far as the base of the fifth metatarsal bone. Between its origin and that point its relations are as follows:—(1) it is under cover of the laciniate ligament; (2) it is placed between the abductor hallucis and the hollow of the calcaneus; (3) it lies between the flexor digitorum brevis and the quadratus plantæ; (4) it occupies the interval between the flexor digitorum brevis and the abductor digiti quinti. In the latter situation it is near the surface, and is covered merely by the integument and fasciæ.

The *branches* which proceed from this part of the vessel are —(1) twigs to the neighbouring muscles; (2) *medial calcanean branches*, which arise near its origin, and gain the heel by passing through the cleft between the flexor digitorum brevis and the abductor hallucis or by piercing the origin of the abductor hallucis; (3) cutaneous branches, which appear through the plantar aponeurosis along the line of the lateral intermuscular septum; (4) twigs to the lateral margin of the foot, which anastomose with the lateral tarsal and arcuate branches of the dorsalis pedis.

Nervus Plantaris Medialis (O.T. **Internal Plantar Nerve**). —The medial plantar nerve arises as the larger of the two terminal branches of the tibial nerve in the hollow of the calcaneus, under cover of the ligamentum laciniatum. It accompanies the medial plantar artery, and has similar relations. After it emerges from under cover of the abductor hallucis it gives off a digital branch to the medial side of the hallux, and then ends, in the interval between the abductor hallucis and the flexor digitorum brevis, by dividing into three terminal digital branches.

The *branches* of the medial plantar nerve are:—

1. Cutaneous twigs to the skin of the sole.
2. Muscular branches.
3. Four digital branches.

The *cutaneous twigs* to the integument of the sole spring from the trunk of the nerve, and pierce the aponeurosis in the line of the medial intermuscular septum.

The digital branches of the medial plantar nerve supply the skin of the plantar surfaces of three and a half toes, the first, second, third, and half the fourth. They also supply the skin over the dorsal aspects of the terminal phalanges of those toes and the joints and ligaments of the toes to which they are distributed.

The *digital nerve to the great toe* supplies the medial side of that toe.

The *three terminal digital branches* pass to the proximal ends of the medial three interdigital clefts, where each divides to supply the adjacent sides of the toes which bound the clefts. From the third terminal digital branch of the medial plantar nerve a communication is given to the superficial part of the lateral plantaı nerve. The digital distribution

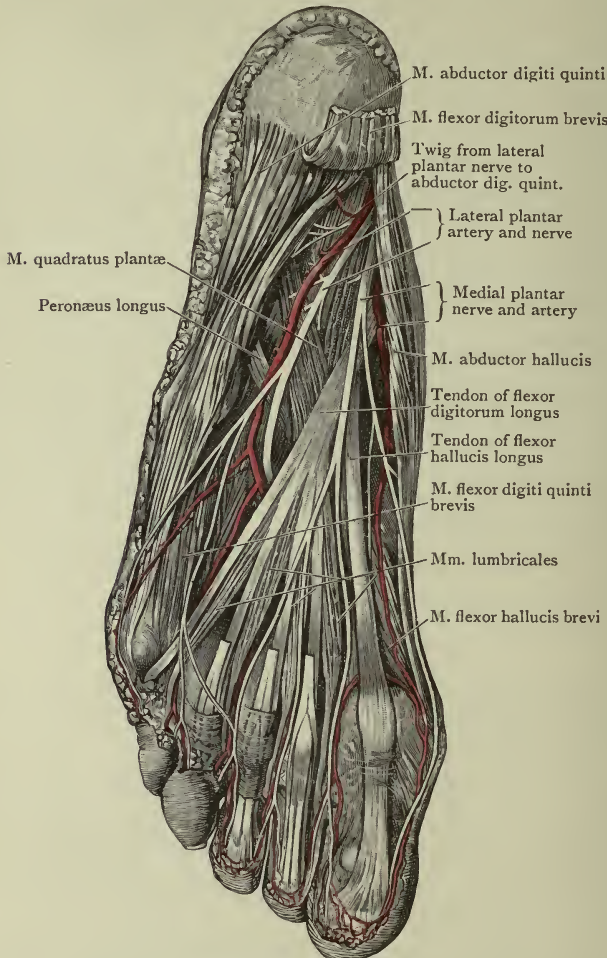


FIG. 171.—Dissection of the Sole of the Foot; the Flexor Digitorum Brevis has been reflected.

of the medial plantar nerve in the foot closely resembles that of the median nerve in the hand.

The *muscular branches* go to four muscles of the sole, viz., the abductor hallucis, the flexor digitorum brevis, the flexor hallucis brevis, and the most medial or first lumbrical muscle. The branches which supply the abductor hallucis and the flexor digitorum brevis arise from the trunk of the medial plantar nerve a short distance from its origin. The nerve to the flexor hallucis brevis arises from the digital nerve to the medial side of the great toe, and the nerve to the first lumbrical muscle springs from the digital nerve which supplies the adjacent sides of the first and second toes.

Nervus Plantaris Lateralis (O.T. **External Plantar Nerve**).—The lateral plantar nerve corresponds to the ulnar nerve in the palm of the hand. It accompanies the lateral plantar artery and possesses the same relations. In the interval between the abductor digiti quinti and the flexor digitorum brevis, opposite the base of the fifth metatarsal bone, it divides into a deep and a superficial part. The *deep division* follows the plantar arch, under cover of the flexor tendons. The *superficial division* divides into two digital branches.

From the trunk of the lateral plantar nerve proceed *two muscular branches*, viz., to the abductor digiti quinti and to the quadratus plantæ.

The *first* or *lateral digital branch* of the superficial part of the lateral plantar nerve goes to the lateral side of the little toe. It also gives muscular twigs to the flexor brevis digiti quinti and the interosseous muscles in the fourth intermetatarsal space.

The *second digital branch* divides to supply the adjacent sides of the fourth toe and little toe. It sends also a twig of communication to the third terminal digital branch of the medial plantar nerve.

> ***Dissection.***—Detach the abductor digiti quinti from its origin, and turn it forwards, in order that a good display may be obtained of the structures composing the second stratum of the sole.

Second Layer of Muscles and Tendons.—As the tendon of the *flexor hallucis longus* enters the sole it grooves the plantar surface of the sustentaculum tali and inclines medially, deep to the tendon of the flexor digitorum longus, towards the great toe. The tendon of the *flexor digitorum longus*, on the other hand, inclines laterally superficial to the tendon of the flexor hallucis longus to reach the middle of the foot, where it divides into four tendons for the lateral four toes. Where the tendons cross, the tendon of the flexor hallucis longus gives a slip to the deep surface of the tendon of the flexor digitorum longus.

Sir William Turner called attention to the fact that the slip, which passes from the tendon of the flexor hallucis longus to the tendon of the flexor longus digitorum, varies greatly in magnitude and in the manner in which it is connected with the flexor tendons of the toes. In the majority of cases it goes to the tendons of the second and third toes or to the tendons of the second, third, and fourth toes; in some cases, however, only to the tendon of the second toe. Very rarely does it divide so as to bring all the tendons of the flexor digitorum longus into connection with the tendon of the flexor hallucis longus.

The *musculus quadratus plantæ*, which is inserted into the tendon of the long flexor of the toes, and also the four *lumbrical muscles*, which arise from the flexor tendons, can now be distinguished. Note the position of the long plantar ligament between the two heads of origin of the quadratus plantæ.

Dissection.—Before the flexor tendons are traced forwards to the toes, the fibrous flexor sheaths of the toes must be displayed and examined. The skin on the plantar aspects of the toes has already been reflected and the digital vessels and nerves have been cleaned. Now remove the remains of the superficial fascia and expose the flexor sheaths.

Each sheath consists of two strong portions, called the digital vaginal ligaments, which lie opposite the bodies of the first and second phalanges and are attached to their margins, and weaker portions, opposite the interphalangeal joints, which are attached to the ends of the adjacent phalanges and the margins of the plantar accessory ligaments of the joints. The stronger parts are to prevent the tendons springing away from the bones when the joints are flexed, whilst the weaker parts allow the movements of the joints to take place.

Clean the surfaces of at least two sheaths, then open one of them by a longitudinal incision, to display the mucous lining and the two tendons which are enclosed by the sheath.

The Flexor Sheaths of the Digits and the Insertions of the Flexor Tendons.—In each digit an osteo-fibrous canal is formed. It is bounded, dorsally, by the plantar surfaces of the phalanges and the plantar ligaments of the interphalangeal joints, and, plantarwards and at the sides, by the fibrous flexor sheaths. Two tendons enter each canal—a tendon of the short flexor of the toe and a tendon of the long flexor. Opposite the posterior part of the first phalanx the short flexor is superficial and the tendon of the long flexor lies between it and the bone, but at the middle of the phalanx the tendon of the short flexor is perforated by the tendon of the long flexor, which passes forwards to be inserted into the base of the terminal phalanx, whilst the tendon of the short flexor, beyond the perforation, splits into two parts which are attached to the margins of the second phalanx.

The osteo-fibrous canal is lined with a mucous sheath, which not only facilitates the play of the tendons, when the muscles are in action, but also forms folds called *vincula* which aid in attaching the tendons to the bones.

There are two sets of vincula, short and long. Two short vincula are present in each sheath. They are short triangular folds containing some yellow elastic tissue. One of them connects the tendon of the long flexor to the plantar ligament of the terminal interphalangeal joint and the adjacent part of the second phalanx, and the other connects the tendon of the short flexor in a similar manner to the plantar ligament of the first interphalangeal joint and to the adjacent part of the first phalanx. The condition is exactly similar to that found in the fingers (Fig. 72). The vincula longa are more slender, they are irregular in number and position.

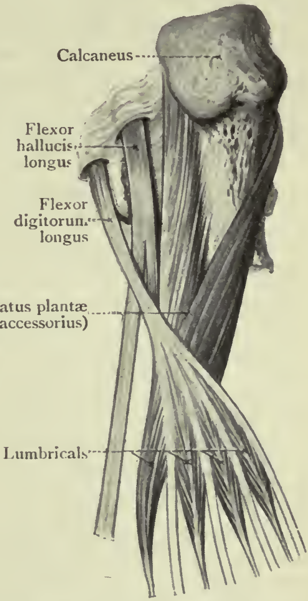


FIG. 172.—Second layer of Muscles and Tendons in the Sole of the Foot.

Tendon of the Flexor Hallucis Longus.—After giving its slip to the tendon of the flexor digitorum longus, the tendon of the flexor hallucis longus is prolonged forwards to the great toe. On the plantar aspect of the hallux it is retained in place by a fibrous flexor sheath, and, finally, it is inserted into the base of the terminal phalanx.

M. Quadratus Plantæ (O.T. Flexor Accessorius).—This muscle takes a course straight forwards from the heel, and acts as a direct flexor of the toes. It also tends to bring the tendons of the long flexor muscle into a line with the toes upon which they operate. It arises by two heads which embrace the calcaneus and the long plantar ligament. The *medial head*, wide and fleshy, springs from the medial concave surface of the calcaneus; the *lateral head*, narrow, pointed, and tendinous, takes origin from the lateral surface of the calcaneus, and also from the long plantar ligament. The quadratus plantæ is inserted into the tendon of the flexor digitorum longus in the middle of the sole. It is supplied by a branch from the *lateral plantar nerve*.

Mm. Lumbricales.—The lumbrical muscles of the foot are not so strong as the corresponding muscles in the palm of the hand. They are four in number, and arise from the tendons of the flexor digitorum longus. The lateral three lumbricals spring from the adjacent sides of the tendons between which they lie; the first or most medial muscle takes origin from the medial side of the tendon of the long flexor which goes to the second toe. The slender tendons of the lumbrical muscles proceed to the medial sides of the lateral four toes, and are inserted into the expansions of the extensor tendons on the dorsal aspects of the proximal phalanges (see p. 346). The *first* or *most medial lumbrical* is supplied by the *medial plantar nerve*: the *others* are supplied by the *lateral plantar nerve*.

Dissection.—To bring the third layer of muscles into view the following dissection must be made:—Divide the two heads of the quadratus plantæ and draw the muscle forwards from under the lateral plantar vessels and nerve. Sever also the tendons of the flexor digitorum longus and the flexor hallucis longus at the point where they emerge from under cover of the ligamentum laciniatum, and turn them towards the toes, after cutting the branch from the lateral plantar nerve to the quadratus plantæ. As the tendons of the long flexor of the toes are turned forwards the lumbrical muscles will be raised, and the twigs which are furnished to the *second*, *third*, and *fourth* by the deep division of the lateral plantar nerve must be looked for. That for the second lumbrical muscle will be seen to take a recurrent course round the transverse head of the adductor hallucis muscle. Lastly, cut the medial plantar nerve close to its origin and turn it aside.

Third Layer of Muscles.—The *flexor hallucis brevis* lies along the lateral side of the abductor hallucis.

The *oblique head of the adductor hallucis* has a very oblique position in the sole, and hides the interosseous muscles to a great extent. It lies to the lateral side of the flexor hallucis brevis.

The *transverse head of the adductor hallucis* is placed transversely across the heads of the metatarsal bones and the plantar ligaments of the metatarso-phalangeal joints.

The *flexor digiti quinti brevis* (O.T. *minimi digiti*) lies upon the fifth metatarsal bone.

The deep division of the lateral plantar nerve and the plantar arterial arch are partially exposed, but they will be more fully displayed at a later stage.

Dissection.—**Clean all the above-named muscles from their origins to their insertions. Clean also the exposed part of the plantar arch.**

M. Flexor Hallucis Brevis.—The short flexor of the great toe arises from the slip from the tendon of the tibialis posterior muscle which goes to the second and third cuneiform bones and from the adjoining part of the *cuboid bone*. It is narrow and tendinous at its origin, but it soon divides into two separate fleshy bellies, which are ultimately inserted one upon each side of the base of the proximal phalanx of the great toe. In the tendons of insertion two large sesamoid bones are developed (Fig. 174). The medial head of the flexor hallucis brevis is closely connected with the tendon of the abductor hallucis, and is inserted in common with it. The flexor hallucis brevis is supplied by the *medial plantar nerve*. It is a flexor of the metatarso-phalangeal joint of the great toe.

M. Adductor Hallucis (O.T. Adductor Obliquus Hallucis and Adductor Transversus Hallucis).—The adductor hallucis consists of two separate portions called the oblique and the transverse heads of the muscle. The **oblique head** arises from the sheath of the peronæus longus tendon and from the bases of the second, third, and fourth metatarsal bones. It tapers as it approaches the root of the hallux, and is inserted, with the lateral head of the flexor hallucis brevis, into the lateral aspect of the base of the proximal phalanx of the great toe. It is supplied by the *deep division* of the *lateral plantar nerve*. The **transverse head** springs by a series of slips from the plantar metatarso-phalangeal ligaments of the third, fourth, and fifth toes, and proceeds transversely medially, under cover of the flexor tendons, to find insertion into the lateral side of the base of the proximal phalanx of the great toe, in common with the oblique head. Its nerve of supply comes from the *deep*

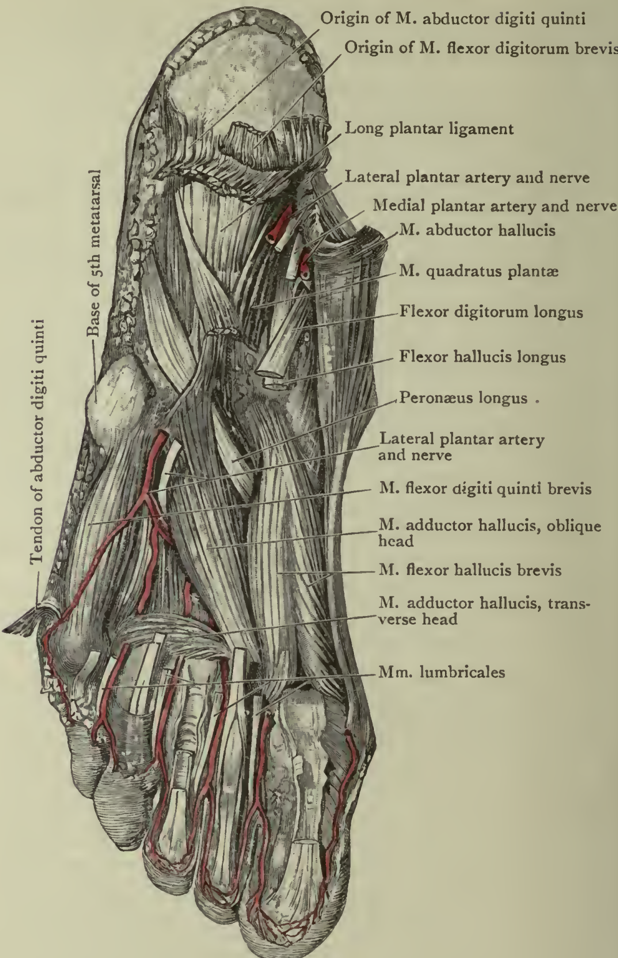


FIG. 173.—Deep Dissection of the Foot; the Superficial Muscles and also the Flexor Tendons, etc., have been removed.

division of the *lateral plantar nerve.* It is an adductor of the great toe.

PLATE XXXV

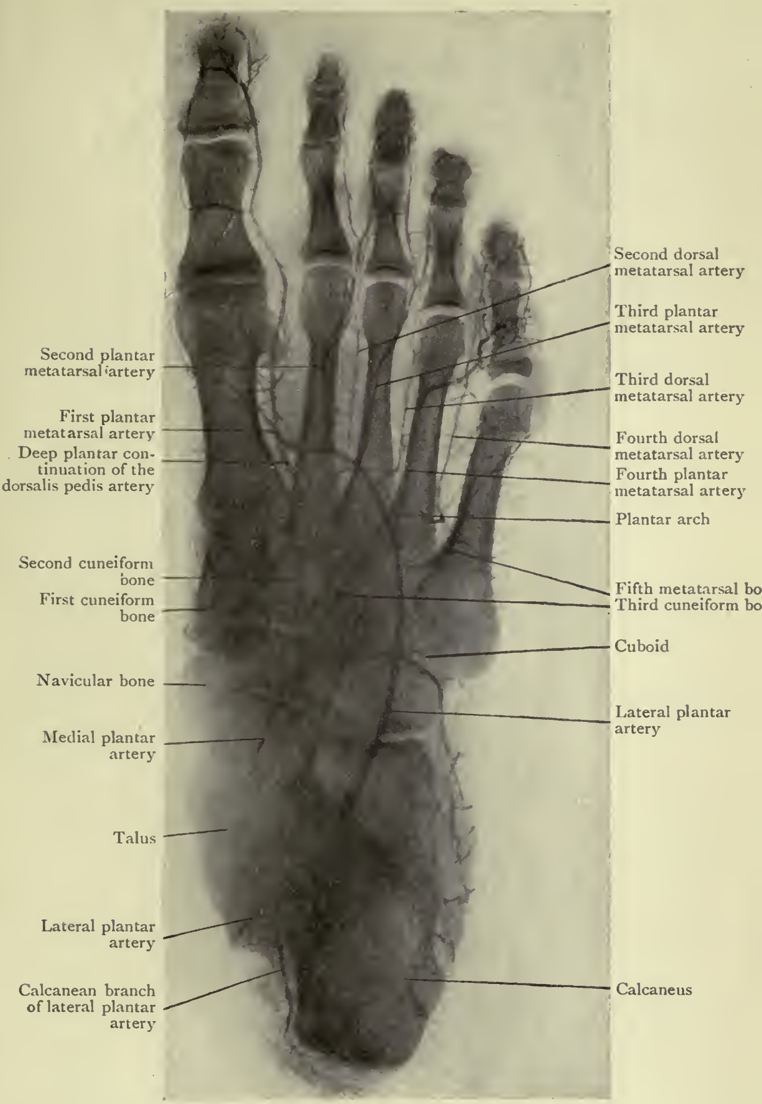


FIG. 174.—Radiograph of an Injected Foot showing the relations of some of the arteries to the bones.

Flexor Digiti Quinti Brevis (O.T. Flexor Brevis Minimi Digiti).—The short flexor of the little toe is a single fleshy slip, which springs from the base of the fifth metatarsal bone and the sheath of the peronæus longus tendon. It is inserted into the lateral side of the base of the proximal phalanx of the little toe. Its nerve of supply arises from the *superficial division* of the *lateral plantar nerve*. It is a flexor of the metatarso-phalangeal joint of the little toe.

Dissection.—**The oblique head of the adductor hallucis, and the flexor hallucis brevis, must now be detached from their origins and thrown towards their insertions, in order that the entire length of the plantar arterial arch, the deep division of the lateral plantar nerve, and the termination of the dorsalis pedis artery may be displayed. As the oblique head of the adductor hallucis is raised the branch which is given to it by the deep division of the lateral plantar nerve must be secured and retained.**

Arcus Plantaris. — The plantar arterial arch is the continuation of the lateral plantar artery across the sole of the foot. It runs from the level of the base of the fifth metatarsal bone to the base of the first interosseous space, where it is joined by the terminal plantar portion of the dorsalis pedis artery. The arch is deeply placed; it rests against the interosseous muscles, close to the proximal ends of the metatarsal bones (Figs. 174, 175), and it is concealed by the flexor tendons, the lumbrical muscles, and the oblique head of the adductor hallucis. It is accompanied by the deep division of the lateral plantar nerve and by two venæ comites.

The branches which proceed from the arch are:—

1. Articular.
2. Posterior perforating.
3. Second, third, and fourth plantar metatarsal arteries.
4. Plantar digital artery to the lateral side of the little toe.

The *articular branches* arise from the concavity of the arch, and run posteriorly to supply the tarsal joints.

The *posterior perforating branches* are three in number. They pass dorsally through the posterior ends of the lateral three intermetatarsal spaces and between the heads of the corresponding dorsal interosseous muscles. Each ends, on the dorsum of the foot, by joining the corresponding dorsal metatarsal artery.

The *second*, *third*, and *fourth plantar metatarsal branches* run forwards opposite the second, third, and fourth intermetatarsal spaces, pass dorsal to the transverse head of the adductor hallucis, and, at the proximal end of the corresponding interdigital cleft, each plantar metatarsal artery ends by dividing into two branches which supply the adjacent sides of the digits bounding the cleft. The branches of the second plantar metatarsal artery supply the adjacent sides of the second and third toes; those of the third supply the adjacent sides of the third and fourth toes; and those of the fourth the adjacent sides of the fourth and fifth toes.

Immediately before it divides, each plantar metatarsal artery sends dorsally an anterior perforating artery which joins the corresponding dorsal metatarsal artery.

Upon the sides of the toes the plantar digital branches of the metatarsal arteries are distributed in exactly the same manner as the digital arteries of the fingers (see p. 155).

The plantar metatarsal branch to the lateral border of the little toe springs from the lateral extremity of the plantar arch, crosses the plantar surface of the flexor digiti quinti brevis, and runs forwards to the distal end of the toe.

The **First Plantar Metatarsal Artery** (O.T. **Arteria Magna Hallucis**) corresponds with the arteria volaris indicis radialis and the arteria princeps pollicis of the hand. It arises from the plantar extremity of the dorsalis pedis, at the point where the latter joins the plantar arch, and runs forwards to the cleft between the great toe and the second toe, where it divides into two branches for the supply of the adjacent sides of the first and second toes. Before it divides, it gives off a branch to the medial side of the great toe which is joined by the terminal part of the medial plantar artery.

Deep Division of the Lateral Plantar Nerve.—The deep division of the lateral plantar nerve accompanies the plantar arch in its course medialwards across the sole. It lies posterior to the arch, and ends in the deep surface of the oblique head of the adductor hallucis. In addition to that muscle it supplies all the interosseous muscles (with the exception of those in the fourth space), the transverse head of the adductor hallucis, and the lateral *three* lumbrical muscles. The twig to the second lumbrical takes a recurrent course round the anterior border of the transverse head of the adductor hallucis.

Dissection.—Detach the transverse head of the adductor hallucis from its origin and throw it medially, towards the hallux, to display the transverse ligament of the heads of the metatarsal bones.

Transverse Ligament of the Heads of the Metatarsal Bones.—The transverse ligament of the heads of the meta-

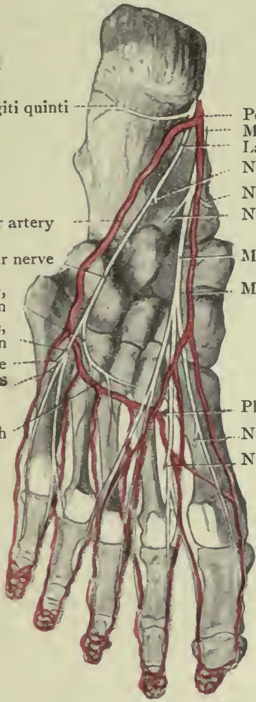


FIG. 175.—Arteries and Nerves of the Sole of the Foot. (Diagram.)
The plantar nerves and their branches are uncoloured.

tarsal bones is a strong fibrous band which stretches across and is attached to the plantar accessory ligaments of the five metatarso-phalangeal joints. It differs from the corresponding ligament of the hand, inasmuch as it includes within its grasp the plantar accessory ligament of the metatarso-phalangeal joint of the first digit.

Dissection.—A satisfactory display of the *interosseous muscles* cannot be obtained unless the transverse ligament is divided

between the heads of the various metatarsal bones. The toes can then be separated more freely from each other, and the interosseous muscles traced to their insertions. It is well, at this stage, to reflect the flexor digiti quinti brevis also.

Interosseous Muscles.—There are seven interosseous muscles, three plantar and four dorsal. The *plantar interosseous muscles* are so placed that they adduct the lateral three toes towards the middle line of the second toe. They arise from the plantar aspects and parts of the medial surfaces of the lateral three metatarsal bones, and each is inserted upon the medial side of the first phalanx of the corresponding toe. The *dorsal interosseous muscles* occupy the four intermetatarsal spaces, and consequently they must be dissected upon both plantar and dorsal aspects of the foot. They are arranged so as to abduct the second, third, and fourth toes from the middle line of the second toe. Each arises by two heads from the dorsal parts of the adjacent sides of the metatarsal bones which bound the cleft in which it lies. They are inserted as follows: the *first*, upon the medial side of the first phalanx of the second toe; the *second*, upon the lateral side of the same phalanx; the *third*, upon the lateral side of the first phalanx of the third toe; and the *fourth*, upon the lateral side of the first phalanx of the fourth toe. The slender tendons of the interosseous muscles are only very slightly attached to the bases of the proximal phalanges. They are inserted for the most part into the expansions of the extensor tendons on the dorsal aspect of the toes (p. 346).

Tendons of the Tibialis Posterior and Peronæus Longus.—Before leaving the sole of the foot the dissector must determine the precise insertions of the tendons of the tibialis posterior and of the peronæus longus. The tendon of the *tibialis posterior* is inserted not merely into the tuberosity of the navicular bone. Fibrous slips are seen to spread out from it, and these may be traced to every bone of the tarsus, with the exception of the talus, and also to the bases of the second, third, and fourth metatarsal bones. As it lies under and gives support to the head of the talus, the tendon of the tibialis posterior has developed within it a sesamoid nodule of fibro-cartilage, and in some cases a sesamoid bone (Fig. 103).

The tendon of the *peronæus longus* turns round the lateral margin of the foot, and runs medially, across the sole, in the groove on the plantar surface of the cuboid bone, to reach the base of the first metatarsal bone. As it traverses the sole it is enclosed in a fibrous sheath. The sheath is formed mainly by fibres derived from the long plantar ligament. Open the sheath, and its smooth, glistening internal surface will be displayed. The glistening appearance is due to the mucous layer which lines it (see p. 354). The tendon is inserted into the plantar part of the base of the first metatarsal bone, and also to a slight degree into the adjacent part of the first cuneiform bone. In some cases it sends a slip to the base of the second metatarsal bone also. As the tendon winds round the cuboid bone it is thickened, and contains a nodule of fibro-cartilage, or a sesamoid bone.

FIG. 176.—The insertions of the Tibialis Posterior and Peronæus Longus Muscles in the Right Foot. (Paterson.)

Dissection. — **The dissection of the sole of the foot is brought to an end by disarticulating the proximal end of the first metatarsal bone. A good view is thus obtained of the continuity between the dorsalis pedis artery and the plantar arch.**

ARTICULATIONS.

The dissection of the knee joint, the ankle joint, the tibiofibular joints, and the various articulations of the foot, may now be proceeded with. It is possible that the ligaments may have become hard and dry. If that is the case, soak the joints in water for an hour or two.

Articulatio Genu (Knee Joint).

In the knee-joint three bones are in apposition, viz., the distal end of the femur, the proximal end of the tibia, and the patella. It is the largest and most complicated articulation in the body; and, when the bones are examined in the dried skeleton, the joint presents an apparent insecurity, because the bony surfaces show little adaptation the one to the other. In reality, however, the knee joint is very strong, and, on account of the strength of the ligaments which retain the bones in place, it very rarely suffers dislocation. The ligaments on the exterior of the joint are:—

1. The capsular ligament.
2. Two collateral ligaments—fibular and tibial.
3. The ligamentum patellæ (or anterior ligament).
4. The oblique popliteal ligament.

Dissection.—Before the dissection of the knee joint itself is commenced, the nerves which supply it, and the arteries which anastomose around it and provide its blood supply should be displayed and studied. To a certain extent they can be dissected simultaneously. The superior, inferior, and middle articular branches of the tibial nerve, the superior and inferior articular branches of the common peroneal nerve, and the articular branch of the obturator nerve were found during the dissection of the popliteal fossa, each being accompanied by a genicular branch of the popliteal artery.

Note that the middle genicular branch of the tibial nerve, the accompanying artery, and the articular branch of the obturator nerve pierce the posterior ligament of the knee joint. They supply structures inside the capsule, but the demonstration of their distribution is very difficult, and no attempt must be made to follow them further at present.

The branches of the femoral nerve to the vastus medialis, the vastus intermedius, and the vastus lateralis send twigs to the knee, and twigs of the descending branch of the lateral femoral circumflex artery descend with the nerve to vastus lateralis to take part in the anastomosis round the joint. The nerves and the artery mentioned were found during the dissection of the thigh. Attempt to trace them now to the knee, and demonstrate, if possible, the anastomosis of the descending branch of the lateral femoral circumflex artery with the superior lateral genicular branch of the popliteal artery, and with the muscular branches of the arteria genu suprema. Next trace the superior genicular branches of the popliteal artery and the accompanying nerves. The medial superior genicular artery, as it leaves the popliteal fossa, pierces the posterior intermuscular septum of the thigh, and then passes between the tendon of the adductor magnus and the femur before it enters the vastus medialis, where it anastomoses with the adjacent arteries. The lateral superior genicular artery, and the accompanying nerve, must be followed through the lateral intermuscular septum, and between the biceps femoris and the bone, into the substance of the vastus intermedius.

As the inferior genicular vessels and nerves are followed care must be taken to avoid injury to the collateral ligaments of the knee joint. Cut through the biceps femoris at the level of the proximal part of the lateral condyle of the femur, pull the distal part downwards, and clean the fibular collateral ligament, which descends from the lateral epicondyle of the femur through the tendon of the biceps to the head of the fibula (Fig. 178). Then follow the inferior lateral genicular artery and nerve forward, between the fibular collateral ligament and the fibrous capsule to the front of the knee. Next throw the tendons of the sartorius, gracilis, and semitendinosus forwards; clean the broad tibial collateral ligament, which descends from the medial epicondyle of the femur to the medial condyle and the medial surface of the tibia; then follow the inferior genicular artery and the accompanying nerve along the proximal border of the popliteus to the point where they disappear under cover of the tibial collateral ligament below the medial condyle of the tibia. Turn now to the anterior border of the tibial collateral ligament, and secure the inferior medial genicular artery as it issues from under cover of the tibial collateral ligament, and, if possible, display its anastomoses with the adjacent arteries.

Now turn to the recurrent branches of the anterior tibial artery. The posterior tibial recurrent artery springs from the anterior tibial artery at the back of the leg and ascends to the knee anterior to the popliteus; therefore that muscle must be reflected. Cut through the narrow part of the muscle, immediately medial to the proximal tibio-fibular joint, and turn the medial part to the medial side; then follow the artery to its termination and at the same time note the termination of the nerve to the popliteus; it enters the anterior surface of the muscle.

The anterior tibial recurrent artery and the accompanying branch of the common peroneal nerve were displayed during the dissection of the anterior and lateral regions of the leg. Follow them now through the proximal part of the origin of the tibialis anterior to their terminations.

Anastomosis around the Knee Joint.—The most important of the anastomoses around the knee joint are placed on the anterior aspect of the articulation, and take the form of three transverse arches. The *most proximal* of these *arterial arcades* passes through the superficial fibres of the quadriceps extensor, close to the proximal border of the patella, and is formed by the union of a branch from the superior lateral genicular artery with a twig from the articular branch of the arteria genu suprema. The middle and the distal transverse arches are both placed under cover of the ligamentum patellæ. The *middle arch* runs across in the fatty tissue close to the distal end of the patella. It is formed by the inferior lateral genicular artery, and a branch which results from the union of a twig from the arteria genu suprema, and another from the superior medial genicular artery. The *most distal arch* lies on the tibia, immediately above its tuberosity, and results from the anastomosis of the anterior recurrent tibial and inferior medial genicular arteries. The proximal and middle of these transverse arches are connected, on each side of the patella, by ascending and descending branches, which anastomose with one another, and thus enclose the patella in an irregularly quadrilateral arterial framework. From all sides of this arterial enclosure, twigs are given off which enter small

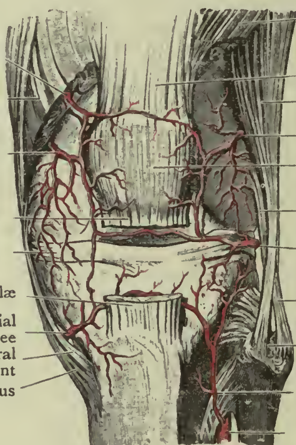


FIG. 177.—Anastomosis on the front of the Left Knee Joint.

foramina on the anterior surface of the patella to supply the osseous substance. Six arteries, therefore, take part in the formation of this system of anastomoses on the front and lateral aspects of the joint, viz., the musculo-articular branch of the arteria genu suprema, the two superior and the two inferior genicular branches of the popliteal, and the anterior recurrent branch of the anterior tibial. In addition to the twigs which proceed from these to form the arterial arches, numerous branches are given which spread over the bones in the form of a close meshwork. During the dissection of the articulation these vessels will become apparent.

The knee joint is supplied on its posterior aspect by twigs derived from all the genicular branches of the popliteal. These twigs are variable in their origin; and the anastomoses which are formed between them are unimportant and inconstant. They are supplemented by another artery, the *posterior recurrent tibial*. This small vessel ramifies over the distal part of the oblique popliteal ligament, and inosculates with the two inferior genicular branches of the popliteal.

The *middle genicular artery* is destined chiefly for the supply of the interior of the joint. It pierces the oblique popliteal ligament, passes forwards between the cruciate ligaments, and ramifies in the fatty tissue in that situation. Its terminal twigs usually anastomose with the middle arch in front of the knee joint. It will be dissected, at a later stage, in the interior of the joint.

Articular Nerves of the Knee Joint.—The knee joint is richly supplied with nerves. No less than ten distinct branches may be traced to it. The femoral nerve, the common peroneal, and the tibial nerve trunks contribute three twigs apiece to this articulation, and the obturator nerve furnishes a filament to its posterior aspect. The *femoral nerve* supplies the joint through branches which proceed from the nerves to the vastus lateralis, vastus medialis, and to the musculus articularis genu portion of the vastus intermedius. These nerves pierce the fibres of the quadriceps muscle, and are distributed to the proximal and anterior part of the articulation. The articular branch from the nerve to the vastus medialis is of larger size than the other two, and it accompanies an articular branch of the arteria genu suprema. The *common peroneal nerve* gives off—(1) the superior and inferior lateral articular nerves, which accompany the corresponding genicular arteries, and end in fine filaments which pierce the capsule of the joint; and (2) the recurrent articular nerve, which accompanies the anterior recurrent tibial artery. This nerve ends chiefly in the tibialis anterior muscle; but a fine twig may reach the distal part of the anterior aspect of the knee joint. The *tibial nerve* furnishes the knee joint with superior and inferior medial articular branches and a middle articular nerve, which accompany the corresponding genicular arteries. The branch from the *obturator nerve* descends on the postero-medial aspect of the popliteal artery as far as the back of the knee joint. At that point it leaves the artery and, inclining forwards, breaks up into several filaments which pierce the oblique popliteal ligament separately.

Dissection.—Remove the popliteal vessels, tibial and common peroneal nerves, and the muscles surrounding the knee joint.

Portions of the tendons of the biceps femoris, semimembranosus, sartorius, semitendinosus, gracilis, and popliteus, together with small pieces of the heads of the gastrocnemius, should be left in place in order that their connections with the ligaments of the joint may be studied. The quadriceps extensor may be divided about three inches proximal to the patella, and the distal part allowed to remain in position.

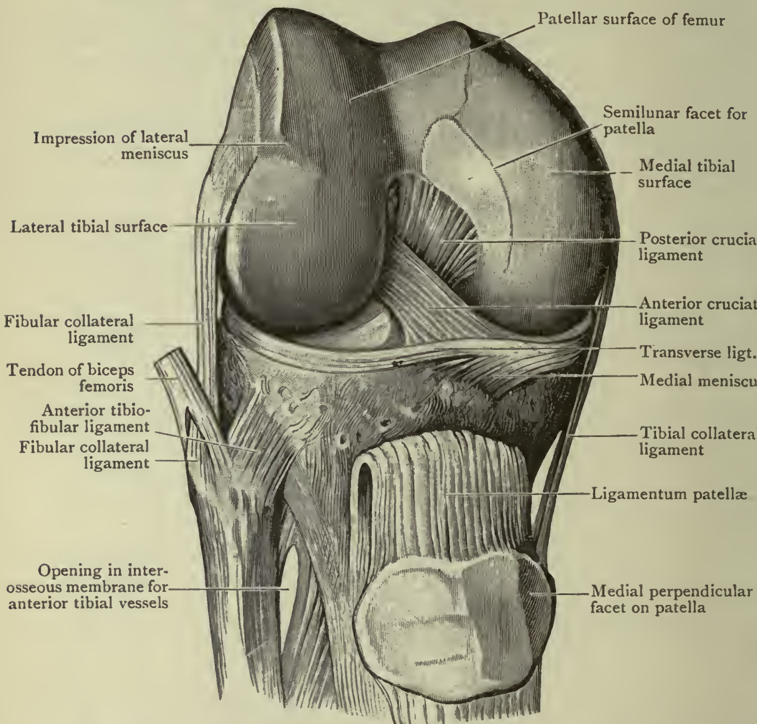


FIG. 178.—Dissection of the interior of the Knee Joint from the front.

Capsula Articularis.—The capsule of the knee joint, together with the tibial collateral ligament and the oblique popliteal ligament, form a complete investment for the joint. In some places the fibrous or peripheral part of the capsule has disappeared and has been replaced either by bone and cartilage or by tendon, and in other places it has been strengthened and extended by the incorporation of adjacent portions of fascia and tendons; thus, anteriorly, the patella entirely replaces a portion of the capsule. Proximal to the patella the capsule is represented merely by the synovial stratum covering the posterior surface of the tendon of the quadriceps muscle; on the other hand the antero-medial and the antero-lateral parts of the capsule have been strengthened by fusion with expansions from the vasti portions of the quadriceps and with the superjacent parts of the fascia lata. The position and attachments of the original capsule are still indicated, in the adult, by the synovial layer which forms a continuous enclosing membrane except in the region of the patella.

Ligamentum Patellæ.—The patellar ligament is situated in relation to the distal part of the front of the capsule. It constitutes, at the same time, the tendon of insertion of the quadriceps extensor muscle and a ligament connecting the patella with the tuberosity of the tibia. Its anterior surface and margins should be carefully defined.

The ligament is a strong band, about two inches long, which is attached proximally to the apex of the patella, and distally to the smooth proximal part of the tuberosity of the tibia. Its superficial fibres are directly continuous, over the surface of the patella, with the central part of the common tendon of the quadriceps extensor. Its deep surface is separated proximally from the synovial layer by the infra-patellar pad of fat, and distally it is separated from the anterior surface of the proximal end of the tibia by the deep infrapatellar bursa (Fig. 181).

Ligamentum Collaterale Fibulare (O.T. External Lateral Ligament).—The fibular collateral ligament is rounded and cord-like. It stands well away from the joint cavity, and takes no part in the formation of the articular capsule. It is attached proximally to a tubercle on the lateral condyle of the femur; distally, it is fixed to the head of the fibula, anterior to the apex. It is closely associated with the tendon of the biceps femoris and the tendon of the popliteus. It splits the tendon of the biceps into two pieces, and extends between them to its fibular attachment. The tendon of the popliteus takes origin from the lateral condyle of the femur distal to and anterior to the femoral attachment of the fibular collateral ligament. As the tendon runs backwards it lies under cover of the fibular collateral ligament, but is separated from it by the articular capsule.

An additional slip is sometimes described as the *posterior part* of the fibular collateral ligament. When present it ends above in the capsule, under cover of the lateral head of the gastrocnemius. Below, it is implanted into the apex of the head of the fibula.

Ligamentum Collaterale Tibiale (O.T. **Internal Lateral Ligament**).—The tibial collateral ligament is a long, flat band, broader in the middle than at either extremity. It springs from the medial epicondyle of the femur, distal to the adductor tubercle. As it descends it inclines slightly forwards, and, finally, it gains attachment to the margin of the medial condyle and to the proximal fourth of the body of the tibia below the medial condyle. At the level of the interval between the femur and the tibia its deep surface is fused with and takes part in the formation of the fibrous stratum of the articular capsule. The main part of the tendon of the semimembranosus extends forwards, under cover of its posterior border, to gain an insertion into the medial condyle of the tibia, whilst, more distally, the inferior medial genicular vessels are carried forwards between it and the tibia. The tendons of the sartorius, gracilis, and semitendinosus lie upon the lower part of its superficial surface, but are separated from it by an intervening bursa.

FIG. 179.—The Fibular Collateral Ligament of the Knee Joint.

The Posterior Part of the Capsule and the Ligamentum Popliteum Obliquum (O.T. **Posterior Ligament**).—The posterior part of the capsule extends as a continuous sheet across the posterior aspect of the joint; laterally it is continuous with the lateral part of the capsule, which lies medial to the fibular collateral ligament, and medially it fuses with the deep surface of the tibial collateral ligament as the latter crosses the line of the joint. The lateral head of the gastrocnemius fuses with the proximal part of its lateral portion, and the tendon of the popliteus passes through the distal part of the same portion. The medial part of the posterior portion of the capsule is separated from the medial head of the gastrocnemius by a bursa which communicates round the medial border of the gastrocnemius with the bursa between the medial head of the gastrocnemius and the semimembranosus, and it may communicate with the cavity of the joint, through an aperture in the capsule. The medial and lateral parts of the posterior portion of the capsule, which are covered by

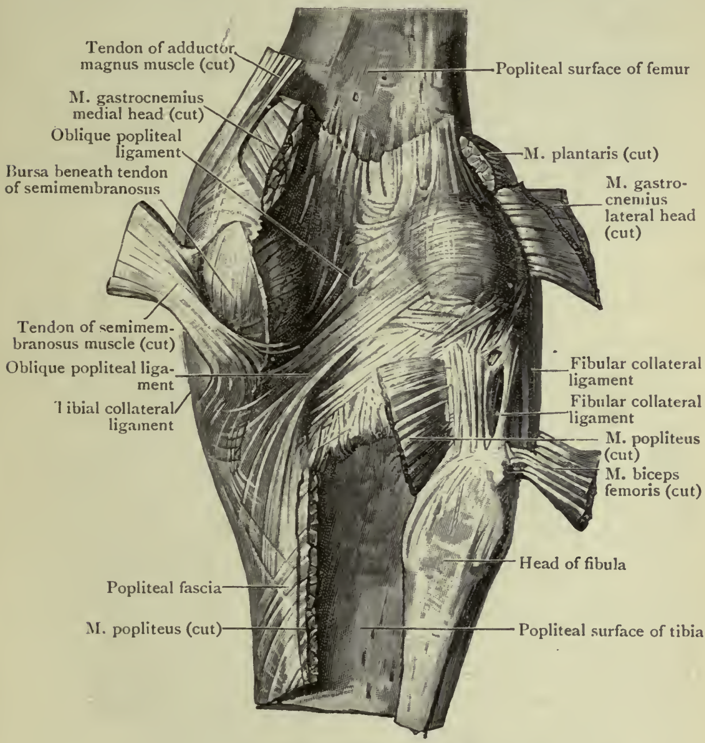


FIG. 180.—The Knee Joint. Posterior view.

the heads of the gastrocnemius, are thin, but the intermediate portion, which forms part of the anterior boundary of the popliteal fossa, is strengthened by a strong oblique band, the *oblique popliteal ligament*, which passes upwards and laterally, from the distal part of the tendon of the semimembranosus to the medial border of the lateral condyle of the femur.

In addition to the apertures through which the bursa under cover of the medial head of the gastrocnemius communicates with the cavity of the joint, and that through which the tendon of the popliteus emerges, there are several small apertures in the posterior part of the capsule for the transmission of vessels and nerves into the interior of the joint.

Dissection.—Make a transverse incision through the quadriceps extensor, immediately proximal to the patella, and prolong each end of the incision downwards, about 37 mm. posterior to the patella, to the condyles of the tibia, then turn the patella downwards. The joint is now opened from the front and the following structures can be seen and examined, viz., the synovial lining, the cruciate ligaments, which connect the femur with the tibia, and the menisci, which lie upon and are attached to the tibia. Immediately above the joint, between the distal part of the quadriceps extensor and the front of the femur there is a large *suprapatellar bursa* which is frequently continuous with the joint cavity. To display the extent of that bursa, split the lower part of the quadriceps by a vertical incision in the middle line of the thigh and turn the two parts aside.

Interior of the Joint.—First note the great pad of soft fat which is placed on the deep surface of the ligamentum patellæ. In vertical section the fatty mass is triangular in form (Fig. 181). It is termed the *infra-patellar pad*, and it fills up the interval between the patella, femur, and tibia, and adapts itself to the varied forms which that recess assumes in the different movements of the joint. It is separated from the interior of the joint by a covering of the synovial layer, and from its surface a fold of that layer extends backwards and upwards to the anterior margin of the intercondylar fossa of the femur, where it is attached. That band is termed the *patellar synovial fold* (O.T. *ligamentum mucosum*). As it approaches the femur it becomes narrow and slender; but where it covers the surface of the infra-patellar pad it is broad and triangular, and presents two free margins which extend along the borders of the distal part of the patella, and receive the name of *plicæ alares* (O.T. *ligamenta alaria*). It must be clearly understood that these are not ligaments in the ordinary sense of the word, but merely folds of the synovial layer.

Stratum Synoviale (O.T. **Synovial Membrane**).—As the knee joint is the largest joint in the body its synovial stratum is more extensive than that of any other joint. It lines the deep surfaces of the ligamentous structures of the lateral, medial and anterior parts of the joint. It lines the deep surfaces of the medial and lateral portions of the posterior part of the capsule also, and from them it is prolonged anteriorly, along the sides and round the front of the cruciate ligaments. In the anterior part of the joint it is prolonged upwards, beyond the articular surface of the distal end of the femur, in the form of a great *cul-de-sac*, under cover of the tendon of the quadriceps (Fig. 181). The proximal extremity of this *cul-de-sac* usually communicates by an orifice of greater or less width with the suprapatellar bursa. The synovial layer also invests the menisci, and a pouch-like diverticulum is prolonged posteriorly and distally, along the tendon of the popliteus, which it partially ensheaths, across the posterior part of the external border of the lateral meniscus to the posterior aspect of the proximal end of the tibia. That prolongation lies in close relation with the capsule of the tibio-fibular joint, and in some cases a communication is established between the cavity of the diverticulum and the cavity of the tibio-fibular joint.

Dissection.—Divide the patellar synovial fold and remove the infrapatellar pad of fat. Then open and examine the bursa between the ligamentum patellæ and the proximal part of the tibia. Next dissect away the intermediate part of the posterior portion of the capsule (oblique popliteal ligament) and trace the middle genicular artery, which pierces it, forwards to the cruciate ligaments. It will now be seen that the posterior surface of the posterior cruciate ligament is not covered by the synovial layer, and that it is connected by areolar tissue to the deep surface of the posterior part of the fibrous stratum of the capsule. Define the attachments of the cruciate ligaments by removing the synovial layer which covers them at the sides and in front, and the areolar tissue in connection with them. The menisci also should receive the attention of the dissector, and the manner in which their fibrous, pointed extremities are fixed to the tibia must be studied. At this stage the changes produced in the degree of tension of the cruciate ligaments, and the change in the position of the menisci brought about by movements of the joint, should be examined.

Movements at the Knee Joint.—The movements of the knee joint are those of flexion and extension. The leg can be bent posteriorly until the prominence of the calf comes into contact with the posterior aspect of the thigh ; but in extension the movement is brought to a close when the leg comes into a line with the thigh. In that position the joint is firmly locked, and the anterior cruciate, the tibial and the fibular collateral ligaments, and the posterior part of the capsule with the oblique popliteal ligament being fully stretched, the leg and thigh are converted into a rigid column of support. In flexion, however, the ligaments mentioned are relaxed, and a certain amount of rotation of the tibia upon the femur is allowed.

Flex the joint acutely, and examine the cartilage-covered surface of the distal end of the femur. It consists of an anterior trochlear portion for the patella, and two condylar surfaces which move on the menisci and tibia. The trochlea is separated from the surface of the lateral condyle by a faintly marked groove, which takes a slightly curved course, from the lateral border of the distal end of the femur, medially and posteriorly to the fore part of the intercondylar fossa. At each extremity this groove widens out into a distinct depression. In full extension the lateral depression rests upon the anterior part of the lateral meniscus, whilst the medial depression rests against the anterior border of the lateral tubercle of the intercondyloid eminence of the tibia (Bruce Young). The line of demarcation between the trochlea and the distal surface of the medial condyle of the femur is not so distinct. Close to the medial margin of the bone there is a

FIG. 181.—Sagittal Section of the Knee Joint.

depression which, in full extension, rests upon part of the anterior horn of the medial meniscus (Bruce Young): but lateral to this the trochlear surface is prolonged posteriorly for a certain distance along the anterior and medial margin of the intercondylar fossa. A portion of the medial condyle is thus included in the trochlear surface, viz., the portion skirting the medial border of the anterior part of the intercondylar fossa, and this is termed the "crescentic facet" of the medial condyle.

The posterior surface of the patella may next be examined (Fig. 178), and its movements in connection with flexion and extension of the knee joint studied. A high vertical ridge divides the posterior surface into a large lateral and a smaller medial area. Each of these is still further subdivided by faint ridges on the cartilage which coats the surface. A faint line upon the medial area of the patella descends in a vertical direction so as to mark off a narrow strip close to the medial border of the bone. This strip is called the *medial perpendicular facet.* Two horizontal lines extend laterally from the lateral border of the medial perpendicular facet to the lateral border of the bone, and subdivide the remainder of the medial area and the whole of the lateral area into three facets each. In a well-marked patella, therefore, the posterior cartilage-covered surface shows seven facets, viz., a proximal pair, a middle pair, a distal pair, and a medial perpendicular facet (Goodsir).

The facetted appearance of the posterior surface of the patella indicates that, in the movements of that bone upon the trochlear surface of the femur, the entire articular surface is never in contact with the femur at the same time. In flexion and extension of the knee, the patella moves distally and proximally in a curved path, the concavity of which looks upwards, backwards, and laterally. The different facets come into contact and break contact with the femur in regular succession. Let us suppose the knee joint to be acutely flexed : in that condition of the limb the medial perpendicular facet of the patella rests upon the crescentic facet of the medial condyle of the femur, while the lateral of the two proximal patellar facets is in contact with the lateral lip of the trochlear surface of the femur. No part of the patella touches the medial lip of the trochlear surface. As the leg is moved from the fully flexed to the fully extended position, the two proximal facets, then the two middle facets, and, lastly, the two distal facets, come successively into contact with the trochlear surface of the femur (Goodsir). In Fig. 182, 183, 187 the position of the patella in the fully extended knee is exhibited.

Now examine the condylar surfaces of the femur (Fig. 178). The posterior two-thirds of the medial condyle will be seen to be of equal extent with, and parallel to, the lateral condyle. The anterior third of the medial condyle, however, turns obliquely laterally to join the trochlear surface. The lateral condylar surface has no corresponding part. The obliquely directed part of the medial condyle gives rise to the "screw-home" movement, which is so characteristic of the knee joint when fully extended. At the commencement of flexion and at the completion of extension there is a screw movement, or a movement of rotation of the tibia and femur on each other. As the leg is moved forwards from the condition of acute flexion, the condyles of the femur roll and glide over the surfaces of the menisci and the proximal end of the tibia until the surface of the lateral condyle, and the corresponding part of the medial condyle, are exhausted. This movement of the femoral condyles has been compared to that of "a wheel partially restrained by a drag" (Goodsir). Any additional movement must necessarily take place in connection with the anterior oblique third of the medial condyle, and the result is a rotation or screw-like motion of the femur medially. The medial condyle travels backwards round the intercondyloid eminence of the tibia, and the anterior part of the intercondylar fossa comes into contact with the anterior cruciate ligament and the medial tubercle of the intercondyloid eminence (Bruce Young). The joint is now "screwed home" or locked. In the initial stage of flexion the reverse movement must be accomplished. The unlocking of the joint can be brought about only by a rotation medially of the tibia, or a rotation laterally of the femur.

When fully extended, the joint is locked, and the posterior part of the capsule, the collateral ligaments, and the anterior cruciate ligaments are tense. The limb is converted into a rigid column, and the upright posture is thereby maintained with the smallest possible degree of muscular exertion.

The **muscles** which operate upon the bones of the leg so as to produce flexion and extension of the limb at the knee joint are :—(1) *extensors*, the four parts of the quadriceps extensor ; (2) *flexors*, the biceps femoris, popliteus, sartorius, gracilis, semitendinosus, and semimembranosus. Of these, only one is inserted on the lateral side of the limb, viz., the biceps. The other five are inserted into the tibia on the medial side of the leg.

Medial rotation is produced by the popliteus, gracilis, sartorius, semitendinosus, and semimembranosus. Lateral rotation by the biceps femoris.

Dissection.—In order to obtain a proper view of the attachments of the cruciate ligaments the following dissection must be made:—The femur must be sawn across about two inches proximal to its distal articular surface. When that has been done divide the distal part of the bone by a vertical, antero-posterior saw-cut, which should end distally in the intercondylar fossa between the condyles and between the proximal attachments of the two cruciate ligaments. After this procedure the cruciate ligaments can be studied singly, or together, and their relation to the collateral ligaments of the joint can be examined. It will be seen that the fibular collateral ligament and the anterior cruciate ligament constitute a pair of ligaments which are fixed to opposite sides of the lateral condyle. The tibial collateral and the posterior cruciate ligaments belong to the medial condyle of the femur, and are attached to its medial and lateral surfaces, respectively. When that relationship has been noted, the tibial collateral ligament may be divided to free the medial condyle, and give greater space for the study of the cruciate ligaments.

Ligamenta Cruciata Genu (O.T. **Crucial Ligaments**).—The cruciate ligaments are well named, because they cross each other, like the limbs of the letter X, in the interval between the two condyles of the femur. This cruciate arrangement is seen whether they are viewed from the side, by the removal of the distal part of one condyle, or from the front or the back of the joint. The anterior cruciate ligament is attached to the tibia in front of the intercondylar eminence and to the medial surface of the lateral condyle of the femur, whilst the posterior is fixed to the tibia behind the intercondylar eminence and to the lateral surface of the medial condyle of the femur.

The *anterior cruciate ligament* springs from the intermediate rough area on the proximal surface of the tibia, in the anterior intercondylar fossa of the tibia, immediately anterior to the medial tubercle which surmounts the intercondylar eminence. Thence it proceeds upwards, backwards, and laterally, to gain attachment to the posterior part of the medial surface of the lateral condyle of the femur (Fig. 186).

The *posterior cruciate ligament* springs from the posterior intercondylar fossa of the tibia posterior to the intercondyloid eminence, and posterior also to the attachments of the posterior horns of both menisci. It passes upwards,

PLATE XXXVI

FIG. 182.—Radiograph of the Knee ot an adult.
(Major T. Rankine.)

PLATE XXXVII

FIG. 183.—Radiograph of the Knee of an adult in extension.
(Prof. Alexis Thomson.)

Note the relations of the femur to the patella and to the tibia.

PLATE XXXVIII

FIG. 184.—Radiograph of a Semiflexed Knee.
(Mr. Hugh M. Martin.)
Note the relations of the femur to the patella and the tibia.

PLATE XXXIX

FIG. 185.—Radiograph of a fully flexed Knee.
(Mr. Hugh M. Martin.)
Note the relations of the femur to the patella and the tibia.

forwards, and somewhat medially, and, crossing the anterior cruciate ligament obliquely, is attached to the anterior portion of the lateral surface of the medial condyle. It receives one, or sometimes two, strong slips from the posterior horn of the lateral meniscus (Fig. 186).

The anterior cruciate ligament is tight *in extension*, and

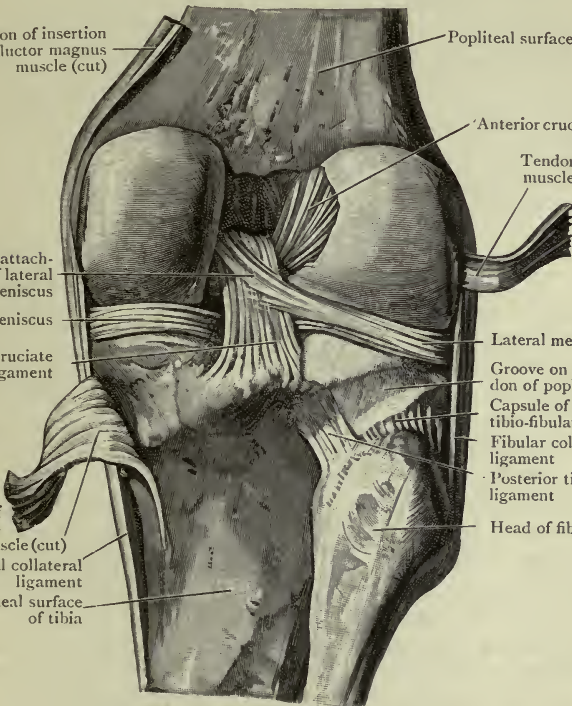


FIG. 186.—The Knee Joint opened from behind by the removal of the Posterior part of the Capsule.

the posterior cruciate ligament is tight *in flexion* of the knee joint.

Menisci (O.T. Semilunar Cartilages).—The menisci are two crescentic plates of fibro-cartilage which are placed on the condylar surfaces of the tibia. They deepen the surfaces upon which the condyles of the femur roll, and, being movable, they fill up the gaps which would otherwise arise during the movements of the joint. Each meniscus presents two fibrous extremities, or horns, which are attached to the rough intermediate surface on the proximal end of the tibia. They are thick towards the circumference of the joint, but thin away to a fine free concave edge in the opposite direction. Both surfaces are smooth and covered with the synovial layer. They do not cover the entire extent of the condylar surfaces of the tibia. The central parts of the latter, as well as the sloping surfaces of the tubercles of the intercondyloid eminence, are free. When the cartilages are raised from the surface upon which they rest, distinct impressions, similar in shape and extent, are seen on the subjacent encrusting cartilage of the tibia.

Dissection.—**Carefully define the attachments of the fibrous horns of the menisci.**

The lateral meniscus is usually somewhat thicker around its circumference than the medial meniscus. It forms the segment of a smaller circle, and its horns being fixed to the tibia close together, a very nearly complete circle is formed. The anterior fibrous horn is attached, immediately in front of the intercondylar eminence, to the lateral side of and partly under cover of the attachment of the anterior cruciate ligament. The posterior horn is fixed to the summit of the intercondylar eminence in the interval between the two tubercles. It gives a strong slip also to the posterior cruciate ligament. The fibular collateral ligament is separated from the lateral meniscus by the lateral part of the articular capsule and also by the tendon of the popliteus which lies inside the fibrous stratum of the lateral part of the capsule. The tendon of the popliteus grooves the posterior part of the lateral border of the lateral meniscus, but behind and in front of the groove the peripheral margin of the lateral meniscus is blended with the internal surface of the fibrous stratum of the articular capsule.

The medial meniscus is semicircular in outline, and forms the segment of a much larger circle than the lateral meniscus. Its anterior fibrous horn is fixed to the anterior part of the anterior intercondylar fossa of the tibia, in front of the attachment of the anterior cruciate ligament; its posterior horn is attached in the posterior intercondylar fossa of the tibia, behind the intercondylar eminence and in front of the attachment of the posterior cruciate ligament. The greater

PLATE XL

FIG. 187.—Radiograph of the Knee of a child.

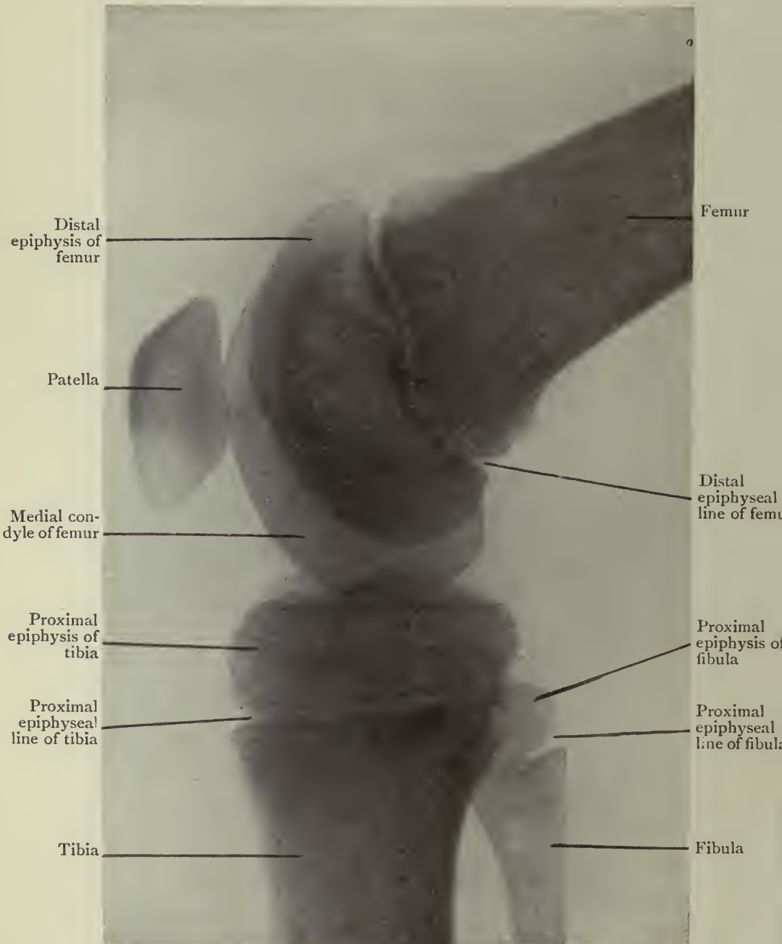


FIG. 188.—Radiograph of the partly flexed Knee of a child. Note the relations of the femur to the patella and the tibia.

PLATE XLII

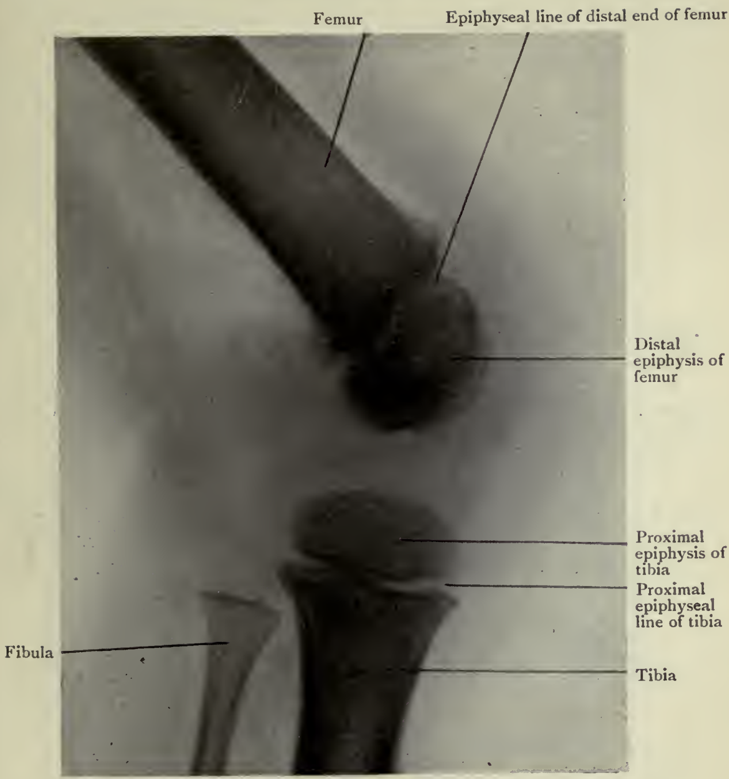


FIG. 189.—Radiograph of the Knee of a child.

Ossification of the patella and the proximal end of the fibula has not yet commenced.

PLATE XLIII

FIG. 190.—Radiograph of the Knee of a child. Ossification of the patella has commenced.

part of the peripheral border of the medial meniscus is closely connected with the deep surface of the fibrous stratum of the articular capsule. Through their connections with the fibrous stratum of the articular capsule both menisci gain attachment to the distal end of the femur and the proximal end of the tibia.

Ligamentum Transversum Genu.—The transverse ligament is a fibrous band which stretches across from the anterior part

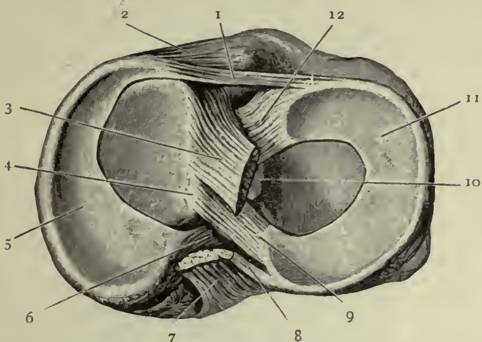


FIG. 191.—Parts attached to the proximal end of the Right Tibia.

1. Transverse ligament.
2. Anterior cornu of medial meniscus.
3. Anterior cruciate ligament.
4. Medial tubercle of intercondyloid eminence of tibia.
5. Medial meniscus.
6. Posterior cornu of medial meniscus.
7. Posterior cruciate ligament.
8. Fasciculus from lateral meniscus to posterior cruciate ligament.
9. Posterior cornu of lateral meniscus.
10. Lateral tubercle of intercondyloid eminence of tibia.
11. Lateral meniscus.
12. Anterior cornu of lateral meniscus.

of one meniscus to the corresponding part of the other, constituting a bond of union between them.

> ***Dissection.***—**The condyles of the femur should now be detached by dividing the fibular collateral ligament, the cruciate ligaments, and the remains of the articular capsule close to their femoral attachments.**

Attachment of Parts to the Proximal Surface of the Tibia.—The ligamentous structures and the menisci are attached to the intermediate area on the proximal surface of the tibia in the following order from before backwards:—(1) The anterior horn of the medial meniscus, on the medial side of the extreme anterior part of the area. (2) and (3) The anterior cruciate ligament and the anterior horn of the lateral meniscus: these are placed side by side, but the attachment of the ligament, which lies to the medial side, overlaps that of the lateral meniscus. (4) The posterior horn of the lateral meniscus, on the summit of the intercondylar eminence between its two tubercles. (5) The posterior horn of the medial meniscus, immediately behind the intercondylar eminence. (6) The posterior cruciate ligament, at the posterior part of the area.

Articulatio Talocruralis (Ankle Joint).

The ankle joint is a diarthrodial articulation of the ginglymus or hinge variety. The articulation takes place

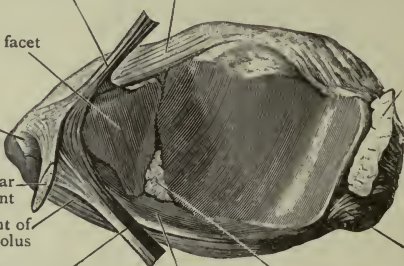


FIG. 192.—Articular Surfaces of Tibia and Fibula which articulate with the Talus.

between the bones of the leg and the talus, and the weight of the body is transferred through it to the foot. It is a joint of great strength; its stability being ensured not only by the powerful ligaments which surround it, but also by the close interlocking of the articulating surfaces.

The bones which enter into the formation of the ankle joint are the distal ends of the tibia and fibula and the proximal, medial, and lateral surfaces of the talus. The distal ends of the leg bones are very firmly united together by interosseous and other ligaments which give the joint a certain amount of elasticity or spring. They form a deep hollow resembling a mortice and the upper part of the talus is received into the cavity.

Dissection.—**Remove the remains of the laciniate and transverse ligaments and cut through and displace the tendons which are in relation with the joint, but do not remove them. Then**

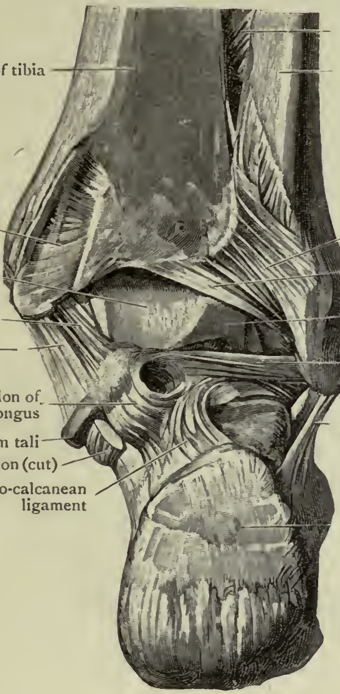


FIG. 193.—Ankle Joint dissected from behind, with part of the Articular Capsule removed.

endeavour to trace out the anastomoses between the arteries in the neighbourhood of the joint, and if possible secure the twigs from the tibial and deep peroneal nerves which supply the joint.

The Arterial Anastomosis around the Ankle Joint.—The arteries which anastomose around the ankle joint are: (1) the malleolar branches of the anterior tibial artery, (2) the perforating branch of the peroneal artery, (3) the terminal part of the peroneal artery. All the vessels are very variable in size, and the malleolar branches of the anterior tibial artery are frequently not injected in ordinary subjects.

The Ligaments of the Ankle Joint are:—

1. Capsula articularis.
2. Ligamentum deltoideum.
3. Ligamentum talofibulare anterius.
4. Ligamentum talofibulare posterius.
5. Ligamentum calcaneo-fibulare.

Dissection.—**After the arterial anastomoses around the ankle joint have been studied pull aside the remains of the arteries and**

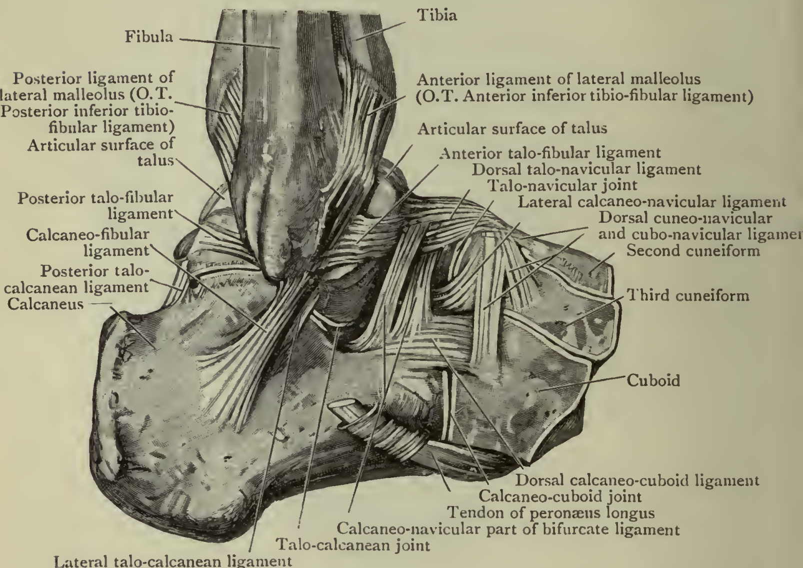


FIG. 194.—Ligaments on the Lateral Aspect of the Ankle Joint and on the Dorsum of the Tarsus.

nerves, and clean carefully the anterior and posterior parts of the capsule, both of which are extremely thin and easily injured. When the attachments and relations of the anterior and posterior parts of the capsule have been demonstrated remove both parts in order to bring the medial and lateral accessory ligaments more fully into relief.

Capsula Articularis.—The anterior and posterior parts of the fibrous stratum of the articular capsule are very thin. Medially the fibrous stratum blends with the deep surface of the deltoid accessory ligament, and laterally it is fused with the deep surfaces of the anterior and posterior talo-fibular ligaments, but it has little or no connection with the calcaneo-fibular ligament. The anterior part of the capsule (O.T. anterior ligament) extends from the anterior margin of the distal articular surface of the tibia to the anterior part of the

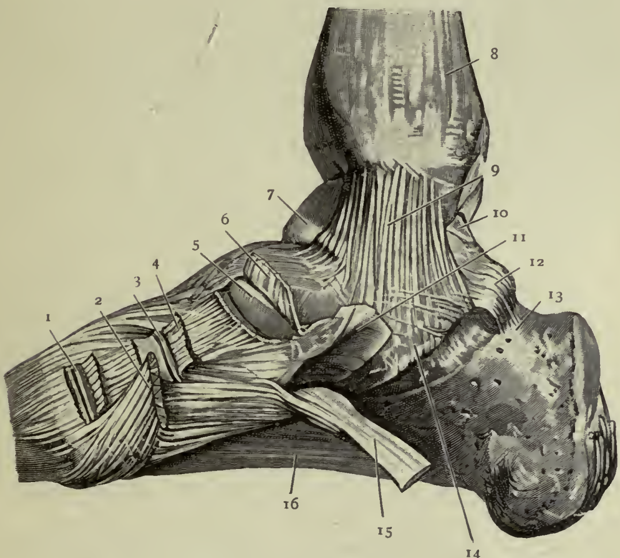


FIG. 195.—Ankle and Tarsal Joints from the Medial Aspect.

1. First tarso-metatarsal joint (opened).
2. Tendon of tibialis anterior muscle (cut).
3. Medial cuneo-navicular joint (opened).
4. Dorsal cuneo-navicular ligament.
5. Head of talus.
6. Dorsal talo-navicular ligament.
7. Trochlear surface of talus.
8. Medial malleolus.
9. Deltoid ligament of the ankle.
10. Trochlear surface of talus.
11. Groove for tendon of tibialis posterior muscle on plantar calcaneo-navicular ligament.
12. Groove and tunnel for the tendon of flexor hallucis longus muscle.
13. Calcaneus.
14. Sustentaculum tali.
15. Tendon of tibialis posterior muscle (cut).
16. Long plantar ligament.

dorsal surface of the neck of the talus. Therefore a transverse vertical cut through the dorsum of the foot, immediately in front of the tibia, will open the ankle joint (see Fig. 197). The very short posterior part of the capsule (O.T. posterior ligament) is attached to the margins of the articular surfaces.

The majority of the fibres of both the anterior and posterior parts of the fibrous stratum of the capsule run transversely.

The Lateral Accessory Bands (O.T. **External Lateral Ligament**).—The lateral accessory bands of the capsule of the ankle joint are three in number. (1) The **anterior talo-fibular ligament**; (2) the **posterior talo-fibular ligament**; (3) the **calcaneo-fibular ligament.**

The *anterior talo-fibular ligament* is the most anterior of the three. It is a flattened band which passes forwards from the anterior border of the lateral malleolus to the body of the talus immediately adjacent to the fibular facet.

The *posterior talo-fibular ligament* is the strongest and the most posterior of the three bands. It runs almost horizontally, from the deep pit posterior to the distal articular surface of the fibula to a prominent tubercle on the posterior surface of the talus.

This tubercle is termed the posterior process of the talus. Generally in the child, and sometimes in the adult, it is a separate piece of bone, attached to the talus by a layer of cartilage and the surrounding periosteum. In such cases it forms a supernumerary tarsal bone which represents the *os trigonum* found in some mammals. If this fact is not kept in mind a fracture of the talus may be diagnosed when the separate bone is seen in a radiograph of an injured ankle (Figs. 200, 201).

The *calcaneo-fibular ligament* is a round, cord-like band which passes from the distal end of the lateral malleolus to the lateral surface of the calcaneus.

Ligamentum Deltoideum (O.T. **Internal Lateral Lig.**).—The deltoid ligament is an accessory band on the medial side of the joint. It is strong and of triangular form. Its apex is attached to a shallow pit on the distal end of the medial malleolus. Its fibres diverge from the apex, and are attached in a continuous line, from before backwards, to the navicular bone, the talus, sustentaculum tali of the calcaneus, and posterior to that to the talus again.

Stratum Synoviale.—The synovial layer lines the internal surface of the fibrous stratum of the capsule described above, and in some cases it sends a small process proximally between the tibia and fibula. It is thrown into a transverse fold anteriorly when the joint is flexed, and into a similar fold posteriorly when the joint is extended.

Relations.—Before the further examination of the joint is proceeded with, replace the tendons, vessels, and nerves and note their relations to the anterior and posterior parts of the articular capsule. Anteriorly, from the medial to the lateral side lie the tibialis anterior, the flexor hallucis longus, the anterior tibial artery, the deep peroneal nerve, and the extensor digitorum longus with the peronæus tertius. The anastomotic branch of the peroneal artery descends across the anterior talo-fibular ligament lateral to the peronæus tertius (Fig. 154). Behind the joint, from the medial to the lateral side, the structures in close relation with the capsule are, the tibialis posterior, the flexor digitorum longus, the posterior tibial artery, the tibial nerve, the flexor hallucis longus, and the terminal part of the peroneal artery. More posteriorly, separated from the flexor hallucis longus by a large pad of fat, is the tendo calcaneus with the tendon of the plantaris on its medial side. The tendons of the tibialis posterior and the flexor digitorum longus lie against the superficial surface of the deltoid ligament, and the tendons of the peronæus longus and brevis cross thé lateral surface of the calcaneo-fibular ligament.

FIG. 196.—Frontal Section through the Ankle Joint, the Tibio-Fibular Syndesmosis, and the Talo-Calcaneal Joints. The deltoid ligament, on the medial side, and the posterior talo-fibular and the calcaneo-fibular ligaments, on the lateral side, are shown in the section. The strong interosseous talo-calcanean ligament is seen forming the lateral boundary of the joint between the head of the talus and the sustentaculum tali. The positions of the distal epiphyseal lines of the tibia and fibula should be observed.

Light blue = articular cartilage.
Striped blue = ligaments.
Green = periosteum.
Red = synovial membrane.

***Dissection.*—Cut through the anterior talo-fibular ligament, the calcaneo-fibular ligament, and the greater part of the deltoid**

ligament, so that the articular surfaces can be separated and examined.

The Articular Surfaces of the Ankle Joint.—The proximal articular area is formed by the distal surface of the tibia, the lateral surface of the medial malleolus, and the medial surface of the lateral malleolus. The three surfaces together form the boundaries of a socket. It is important to note that the socket is wider in front than it is behind, and that it is concave both from side to side and from before backwards. The distal articular area is formed by the dorsal surface of the body of the talus and by parts of its medial and lateral surfaces. It also is broader in front than behind. It is generally convex both from before backwards and from side to side, and it fits into the socket formed by the bones of the leg. When the joint is dorsi-flexed, that is, when the toes are turned upwards, the broad part of the distal articular area rotates backwards into the narrow part of the proximal articular area and the joint becomes locked. When the joint is plantar-flexed, that is, when the toes are turned downwards, the narrow part of the distal articular area moves forwards into the wide part of the proximal articular area and a small amount of side to side movement becomes possible.

Movements.—The movements which take place at the ankle joint are —(1) dorsal-flexion (sometimes called flexion); (2) plantar-flexion (sometimes called extension); and (3) a very limited degree of lateral movement when plantar-flexion is complete. The two principal movements (dorsi-flexion and plantar-flexion) take place around a horizontal axis, which is not transverse, but which is directed laterally and posteriorly, so that it is inclined to the median plane of the body at an angle of about 60° (Krause). This horizontal axis passes through or near the interosseous canal between the calcaneus and talus (Henle). As the articular cavity formed by the tibia and fibula, and also the part of the talus which plays in it, are broader in front than behind, it follows that the more completely the ankle joint is dorsi-flexed, the more tightly will the talus be grasped between the two malleoli. In the erect position the talus is held firmly in the bony socket, and portions of its articular surface project both in front of and behind the tibia. The line of the centre of gravity falls anterior to the ankle joint, and as a result the bones are kept firmly locked. When, on the other hand, the ankle joint is fully plantar-flexed (as when we rise on tip-toe) the narrower posterior part of the talus is brought into the socket, and thus a limited amount of lateral movement is allowed. In *dorsi-flexion* the calcaneo-fibular and posterior talo-fibular bands, the greater part of the deltoid ligament, and the posterior part of the capsule are put on the stretch. In *plantar-flexion* the anterior talo-fibular ligament, the anterior fibres of the deltoid ligament, and the anterior part of the capsule are rendered tense.

The **Muscles** principally concerned in producing dorsi-flexion of the foot at the ankle joint are the tibialis anterior, the extensor digitorum longus, the extensor hallucis longus and the peronæus tertius; those which operate as plantar-flexors are the superficial muscles of the calf, the tibialis posterior, the long flexors of the toes, and the peronæus longus and brevis.

Tibio-fibular Joints.

The fibula articulates with the tibia by both its proximal and its distal extremity. The proximal of the two joints, the *articulatio tibiofibularis*, is a diarthrodial joint, possessing a cavity and a capsule with accessory thickenings. The distal joint is a syndesmosis, the *syndesmosis tibiofibularis*, but in some cases a prolongation of the cavity of the ankle joint projects between the distal ends of the tibia and fibula (Fig. 196). The interosseous membrane which occupies the interval between the bodies of the bones may be regarded as a ligament common to both joints.

Dissection.—Preparatory to the examination of the tibio-fibular joints the foot must be removed by dividing the remains of the ligaments on the medial and lateral aspects of the ankle joint. The muscles also must be detached from both aspects of the interosseous membrane and from the bones of the leg. The ligaments may now be defined.

Membrana Interossea Cruris.—The interosseous membrane is a strong membrane which stretches across the interval between the two bones of the leg, and greatly extends the surface for the origin of muscles. It is attached on the one hand to the interosseous border of the tibia, and on the other to the interosseous border of the fibula. It is composed of strong oblique fibres, which take a direction distally and laterally from the tibia to the fibula. In the proximal part of the membrane, immediately distal to the lateral condyle of the tibia, there is an oval opening for the passage of the anterior tibial vessels, whilst a small aperture, a short distance proximal to the ankle joint, marks the point where the membrane is pierced by the perforating branch of the peroneal artery.

Articulatio Tibiofibularis (O.T. **Superior Tibio-fibular Joint**).—At the tibio-fibular joint the bones are held in apposition by a capsule which is strengthened anteriorly and posteriorly. The fibres of the strengthening bands pass, distally and laterally, from the lateral condyle of the tibia to the head of the fibula. The posterior band is the weaker of the two, and the tendon of the popliteus with its synovial investment rests upon its proximal part. The investment is a prolongation from the synovial layer of the knee joint, and in some cases it will be found to be directly continuous with the synovial layer of the capsule of the tibio-fibular joint.

The fibular collateral ligament of the knee joint and the tendon of the biceps femoris muscle have important relations

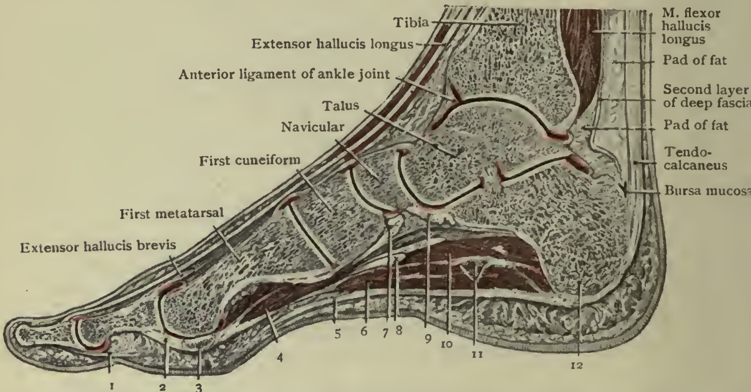


FIG. 197.—Oblique sagittal section through the Foot, along a plane extending from the centre of the heel behind to the centre of the great toe in front.

1. Flexor hallucis longus.
2. Plantar accessory metatarso-phalangeal ligament.
3. Sesamoid bone.
4. Flexor hallucis brevis.
5. Plantar aponeurosis.
6. M. flexor digitorum brevis.
7. Tibialis posterior tendon.
8. Flexor digitorum longus tendon.
9. Plantar calcaneo-navicular ligament.
10. M. quadratus plantæ.
11. Lateral plantar vessels and nerve.
12. Calcaneus.

to the joint. Both are attached to the head of the fibula, lateral to the joint, and some of the tendinous fibres of the biceps extend forwards to the lateral condyle of the tibia. Additional support is thus afforded to the proximal tibio-fibular joint.

Syndesmosis Tibiofibularis (O.T. **Inferior Tibio-fibular Joint**) (Figs. 193 and 196).—The distal tibio-fibular articulation is constructed upon a stronger plan than the proximal, because the strength of the ankle joint very largely depends upon its security. *In some cases* a very narrow strip of the distal part of each of the opposing surfaces of the bones is articular and coated with cartilage continuous with the cartilage on the distal ends of the tibia and fibula where they take part in the formation of the ankle joint; *in other cases articular cartilage is entirely absent.* The surfaces of the proximal part of the syndesmosis are always rough, and are held together by an exceedingly strong *interosseous ligament.*

In addition to the important interosseous ligament three other ligaments are present:—

1. Lig. malleoli lateralis anterius (O.T. Ant. inf. tibio-fibular ligament).
2. Lig. malleoli lateralis posterius (O.T. Post. inf. tibio-fibular ligament).
3. Distal ligament of the lateral malleolus.

The *anterior* and *posterior ligaments* are flat strong bands which pass from the tibia to the fibula, in an oblique direction, laterally and distally.

The distal part of the posterior ligament forms a strong narrow band of yellowish fibres, which takes a transverse course on the back of the joint and is firmly attached to both tibia and fibula, filling up the interval between them. It constitutes a part of the tibio-fibular socket for the talus at the ankle joint (Figs. 192 and 193); and on the proximal aspect of the articular surface of the talus, the area over which it plays is usually easily distinguished. This portion of the posterior ligament is called the *distal ligament* of the lateral malleolus.

Dissection.—To see the interosseous ligament of the tibio-fibular syndesmosis the bones of the leg may be sawn through about two inches from the distal end of the tibia, and then divided with the saw proximo-distally in a vertical-transverse, or frontal direction. This cut should be planned so as to pass through the tibio-fibular syndesmosis. The short strong fibres of the interosseous ligament will then be seen, and also the short narrow articular interval between the distal portions of the opposing surfaces of the bones when that interval is present. If a cavity is present in the distal part of the joint the synovial layer of the capsule of the ankle joint is prolonged proximally over the inner surface of those parts of the ligaments of the tibio-fibular syndesmosis which help to form the boundaries of the cavity.

Articulations of the Foot.

The articulations of the foot are very numerous. They consist of:—

1. Articulationes intertarseæ, tarsometatarseæ, and intermetatarseæ.
2. Articulationes metatarso-phalangeæ.
3. Articulationes digitorum pedis.

The bones which enter into these articulations are the seven tarsal bones, the metatarsal bones, and the phalanges. The tarsal and metatarsal bones are bound together by interosseous, plantar, and dorsal ligaments, and are disposed in the form of two arches, viz., a longitudinal and a transverse. The integrity of these arches is maintained: (1) partly by the forms of the bones; (2) partly by the tension of the ligaments; (3) partly by supporting tendons; and (4) partly by the tension of the plantar aponeurosis.

The longitudinal arch presents a greater height and a wider span along the medial than along the lateral side of the foot. The talus lies at the summit of this arch and forms its keystone. The posterior pillar of the longitudinal plantar arch is short and solid, being formed by the calcaneus alone; the anterior pillar, much longer, is composed of several bones, viz., the navicular, the cuboid, the three cuneiforms, and the metatarsus. Further, the anterior pillar may be considered as being formed of a medial column composed of the navicular, the three cuneiform, and the medial three metatarsal bones, and a lateral column composed of the cuboid and the lateral two metatarsal bones. The weight of the body is transmitted to the summit of the arch through the talus, and the most important ligaments concerned in the prevention of excessive flattening of the arch lie in the plantar concavity; they are the *plantar calcaneo-navicular*, the *long plantar ligament*, the *plantar calcaneo-cuboid ligament*. The various slips of the *tendon of the tibialis posterior*, as they pass to find attachment to the different tarsal and metatarsal bones, give additional support. The *plantar aponeurosis* is also an important factor, for, as it extends between the two pillars and is attached to both, it operates, as the late Sir George Humphry once pointed out, in the same manner as the "tie-beam" of a roof. The transverse arch of the foot is seen to best advantage across the line of the tarso-metatarsal articulations.

Dissection.—The muscles and tendons which have hitherto been only partially detached from the bones of the foot should now be completely removed and the ligaments defined.

Taloid Articulations.—The talus articulates by means of the large posterior facet on the plantar surface of its body with the corresponding posterior facet on the dorsal surface of the calcaneus. Its head, on the other hand, is received into a large socket, which is formed for it by the sustentaculum tali of the calcaneus, the navicular, and two ligaments which pass between the calcaneus and the navicular—viz., one below, the plantar calcaneo-navicular, and another on the lateral side, the calcaneo-navicular part of the bifurcate ligament. The two taloid articulations are quite distinct.

The ligaments which hold the talus in its place are five in number. Four are attached to the calcaneus and one to the navicular bone. They are :—

1. Lig. talo-calcaneum interosseum.
2. Lig. talo-calcaneum laterale.
3. Lig. talo-calcaneum mediale.
4. Lig. talo-calcaneum posterius.
5. Lig. talo-naviculare [dorsale].

The *interosseous talo-calcanean ligament* is by far the most powerful. It occupies the tarsal canal, and consists of strong fibres attached distally to the groove between the articular facets on the dorsal surface of the calcaneus, and proximally to the corresponding groove on the plantar surface of the talus.

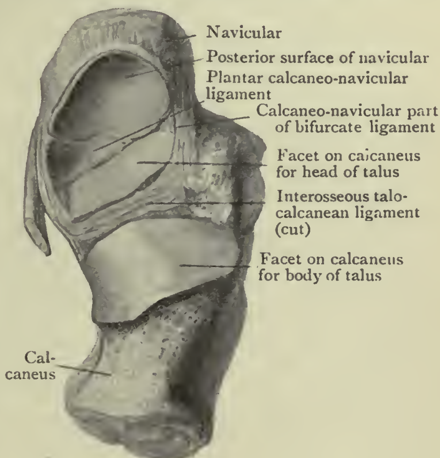


FIG. 198.—Talus removed so as to show the socket for its head.

The *lateral ligament* is a short band of fibres which proceeds from the lateral surface of the talus to the lateral surface of the calcaneus. It is parallel with the calcaneo-fibular ligament of the ankle joint, but it is placed on a deeper plane, and lies somewhat more anteriorly.

The *medial talo-calcanean ligament* passes distally and forwards, from the medial border of the groove on the talus for the flexor hallucis longus to the sustentaculum tali.

The *posterior talo-calcanean ligament* passes from the posterior border of the talus to the calcaneus. It closes the posterior talo-calcanean articulation behind.

The *dorsal talo-navicular ligament* extends, on the dorsum of the foot, from the head of the talus to the navicular bone. It is thin and membranous.

The medial and lateral parts of the capsule of the ankle joint also help to keep the talus in its place.

Dissection.—Divide the various ligaments which hold the talus in place, and remove the bone. When that has been done the different parts which form the socket for the head of the talus can be examined, and it will be obvious that the posterior talo-calcanean articulation is completely cut off from the anterior by the strong interosseous talo-calcanean ligament. The great strength of that ligament can now be appreciated, and the three facets on the head of the talus studied :—(1) a convex surface which looks forwards and articulates with the navicular; (2) an elongated facet on its plantar aspect (sometimes divided into two), which rests upon the sustentaculum tali; and (3) between 1 and 2, a triangular facet which corresponds with the dorsal surface of the plantar calcaneo-navicular ligament. In the recent state (and indeed usually also in the macerated condition of the bone) these three facets are very distinctly mapped off from each other by intervening ridges.

Calcaneo-navicular Ligaments.—Although the calcaneus does not directly articulate with the navicular bone, it is connected with it by two powerful ligaments, viz., a plantar calcaneo-navicular ligament and the calcaneo-navicular part of the bifurcate ligament.

The upper surface of the *plantar calcaneo-navicular ligament* (O.T. *inferior calcaneo-scaphoid ligament*) is brought into view by the removal of the talus. It fills up the angular gap between the sustentaculum tali and the navicular bone, and enters into the formation of the socket for the head of the talus (Fig. 198). Its upper surface is smooth and covered with a synovial layer; its plantar surface is supported by the tendon of the tibialis posterior. This ligament has an important part to play in maintaining the integrity of the longitudinal arch of the foot. Posteriorly it is attached to the anterior border of the sustentaculum tali, whilst anteriorly it is fixed to the plantar surface of the navicular bone.

The *calcaneo-navicular part of the bifurcate ligament* (O.T.

external calcaneo-scaphoid ligament) also forms a part of the socket for the head of the talus. It is placed deeply in the anterior part of the depression between the calcaneus and the head of the talus, and is the medial part of the V-shaped *ligamentum bifurcatum*, which springs from the

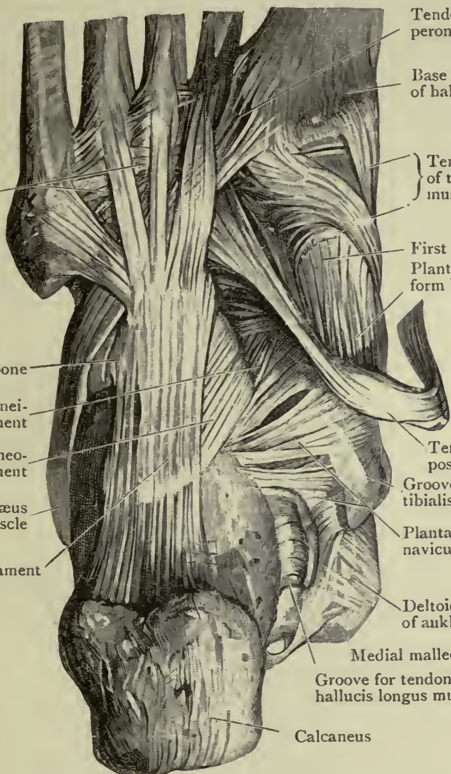


FIG. 199.—Plantar Aspect of Tarsal and Tarso-metatarsal Joints.

anterior part of the upper surface of the calcaneus and immediately divides into a medial or navicular part and a lateral or cuboid portion. The calcaneo-navicular part is continuous below and medially with the plantar calcaneo-navicular ligament, and dorsally with the talo-navicular ligament.

Calcaneo-cuboid Articulation.—In the calcaneo-cuboid joint the concavo-convex surface on the anterior aspect of the calcaneus articulates with the corresponding surface on the posterior aspect of the os cuboideum. It is a distinct joint, that is, its cavity does not communicate with the cavities of neighbouring joints. The *ligaments* which bind the two bones together are:—

1. Capsula articularis.
2. Ligamentum calcaneo-cuboideum plantare.
3. Ligamentum plantare longum.

The *capsule* completely surrounds the joint and its dorsal and medial parts, which are somewhat thickened, are sometimes called the dorsal and medial ligaments of the joint. The medial ligament is the calcaneo-cuboid part of the lig. bifurcatum mentioned above.

The *long plantar ligament* springs from the plantar surface of the calcaneus, immediately anterior to the tuber calcanei. It extends forwards to the plantar surface of the cuboid bone where it broadens out and is, for the most part, attached to the tuberosity of that bone. Numerous strong fibres, however, are prolonged forwards, across the tendon of the peronæus longus, to gain attachment to the bases of the second, third, and fourth metatarsal bones. The long plantar ligament, therefore, extends over the greater part of the plantar aspect of the lateral portion of the tarsus, and is the longest of the tarsal ligaments. Further, it forms the greater part of the sheath of the tendon of the peronæus longus.

The *plantar calcaneo-cuboid ligament* (O.T. *short plantar ligament*) is placed under cover of the long plantar ligament. Slip the knife between them and carry the cutting edge backwards so as to detach the long plantar ligament from the plantar surface of the calcaneus. When the detached band is thrown forwards the plantar calcaneo-cuboid ligament comes into view, and little dissection is required to make its connections apparent. It is composed of short, strong fibres, not more than an inch in length. They spring from the small tubercle on the anterior part of the plantar surface of the calcaneus, and are attached, anteriorly, to the plantar surface of the cuboid, posterior to its tuberosity. The ligament is broader than the long plantar ligament and could be seen at the medial border of the latter before it was reflected.

In the maintenance of the longitudinal arch of the foot, the long plantar ligament and the plantar calcaneo-cuboid ligament have an importance which is surpassed only by that of the plantar calcaneo-navicular ligament.

The joint between the talus and the navicular and that between the calcaneus and the cuboid are frequently referred to together as the *transverse tarsal joint*. It is there that some parts of the movements of eversion and inversion of the foot take place. It should be noted that all the ligaments which connect together the anterior and the posterior segments of the tarsus at this joint, except one, are attached posteriorly to the calcaneus. They are :—

Plantar calcaneo-navicular,	Attached to the calcaneus.
Bifurcate,	
Long plantar,	
Plantar calcaneo-cuboid,	
Calcaneo-cuboid capsule,	
Dorsal talo-navicular,	Attached to the talus.

Inter-cuneiform Articulations.—The three cuneiform bones are held together so firmly that very little individual movement is permitted. The chief uniting structures are *two* strong *interosseous ligaments* which pass between the non-articular portions of their opposed surfaces. These can be seen only when the bones are separated from each other. *Dorsal inter-cuneiform ligaments* also are present. These are short, flat, transversely-placed bands.

Cuneo-navicular Articulation.—The three cuneiform bones articulate with the anterior surface of the navicular. They are held in position by *dorsal ligaments*, which pass from the dorsal surface of the navicular to the dorsal surface of each of the cuneiform bones, and by *plantar ligaments*, which are similarly disposed. The strength of the plantar ligaments is greater than that of the dorsal ligaments, and they are reinforced very largely by slips from the tendon of the tibialis posterior.

Dissection.—The dissector may now divide freely all the dorsal and the most medial of the plantar cuneo-navicular ligaments. The navicular bone can then be drawn backwards so as to expose the interior of the joint. The knife may also be carried round the lateral side of the lateral calcaneo-navicular ligament. A much better view of this ligament is thus obtained, although this dissection entails the division of the dorsal cubo-navicular ligament.

The convex anterior articular surface of the navicular fits into a transversely concave socket, which is formed for it by the posterior surfaces of the three cuneiform bones, and, often, by a small facet on the medial surface of the cuboid as well. The articular surface of the navicular is divided by prominent ridges into areas or facets corresponding with the different parts of the socket in which it lies. The *synovial stratum*, which lines this joint, is prolonged forwards into the intercuneiform joints.

Cubo-navicular and Cubo-cuneiform Articulations.—It has been noted that the anterior pillar of the longitudinal arch of the foot consists of a lateral and a medial column. The tarsal portions of these are connected together by the cubo-navicular and the cubo-cuneiform articulations.

It is only occasionally that the navicular touches and articulates directly with the medial surface of the cuboid. When it does so, the facet on the cuboid lies in series with the articular surfaces on the posterior ends of the cuneiform bones, and forms with them the socket for the anterior surface of the navicular. The *ligaments* which bind the navicular to the cuboid are disposed transversely, and consist of—(1) a series of short strong *interosseous* fibres which bind the opposed surfaces together; (2) a dorsal band; and (3) a plantar band.

The dorsal band has previously been divided in exposing the interior of the cuneo-navicular joint and in defining the lateral calcaneo-navicular ligament, but the interosseous and plantar ligaments may be readily displayed.

The cuboid, by an oval facet on its medial surface, articulates with the third cuneiform bone, forming thereby the *cubo-cuneiform joint*. The two bones are bound together by *interosseous*, *dorsal*, and *plantar ligaments*. By dividing the dorsal ligament and insinuating the knife between the two bones the interosseous ligament may be detected. It is the strongest of the three ligaments.

The *synovial layer* which lines the cuneo-navicular articulation is prolonged into the cubo-cuneiform joint and also into the naviculo-cuboid joint, when that exists.

Tarso-metatarsal Articulations.—The bases of the five metatarsal bones articulate with the three cuneiform bones and the cuboid bone, and are very firmly attached to them by dorsal, plantar, and interosseous ligaments. It is particularly important to note that the line of articulation is irregular, and that the base of the second metatarsal bone is wedged between the first and third cuneiform bones.

The *dorsal ligaments* are flat, distinct bands which can readily be defined by the careful dissector. *One* such ligament passes to the base of the first metatarsal from the first cuneiform; *three*, one from each of the cuneiform bones, proceed to the base of the second metatarsal; *one* extends from the third cuneiform to the base of the third metatarsal; *two*, of which one proceeds from the third cuneiform and the other from the cuboid, go to the base of the fourth metatarsal; and *one* passes from the cuboid to the base of the fifth metatarsal.

The *plantar ligaments* are not so regularly disposed. Those in connection with the first and second metatarsal bones are very strong. Some of the bands have an oblique direction, and those which go to the bases of the second, third, and fourth metatarsal bones are more or less connected with the sheath of the tendon of the peronæus longus, and therefore with the long plantar ligament.

To bring the *interosseous ligaments* into view, divide freely the dorsal ligaments, and then forcibly bend the metatarsus plantarwards upon the tarsus. The interosseous ligaments will resist this proceeding, and on looking into the joints the dissector will see them stretched and tense. If the force is continued they will rupture. The interosseous ligaments are three in number, viz., a medial, an intermediate, and a lateral.

The *medial interosseous ligament* is an exceedingly strong band, which passes laterally from the anterior part of the lateral surface of the first cuneiform bone to the adjacent surface of the base of the second metatarsal bone. The *intermediate interosseous ligament* is small. It passes between the anterior part of the medial surface of the third cuneiform and the adjacent surface of the base of the second metatarsal. The *lateral interosseous ligament* passes from the lateral surface of the third cuneiform bone to the medial side of the base of the fourth metatarsal. One interosseous ligament, therefore, passes from the first cuneiform bone and two from the third cuneiform; and of these, two are attached to the base of the second, and the third to the base of the fourth metatarsal bone.

Tarso-metatarsal Articular Surfaces.—The manner in which the metatarsus is implanted upon the tarsus should now be examined. The *first metatarsal* rests against the first cuneiform, and this joint possesses a separate synovial cavity. The *second metatarsal* rests against the second cuneiform, but its base is grasped by the projecting anterior ends of the first and third cuneiform bones, with both of which it articulates, and with both of which it is connected by interosseous ligaments. It is not surprising, therefore, that this metatarsal should possess so little power of independent movement, and present a difficulty to the surgeon when he is called upon to amputate the anterior part of the foot through the tarso-metatarsal articulation. The *third metatarsal* rests against the third cuneiform. The *synovial layer* which lines the joints between the tarsus and the second and third metatarsal bones is continuous with that which is present between the first and second cuneiform bones, and through that with the synovial layer of the cuneo-navicular articulation. The bases of the *fourth* and *fifth metatarsal bones* are supported by the cuboid, but that of the fourth, by its medial margin, articulates also with the third cuneiform. The joint formed between the lateral two metatarsal bones and the tarsus has a capsule and a cavity separate from that of the adjacent joints.

Intermetatarsal Joints.—The bases of adjacent metatarsal bones, with the exception of the first, articulate with each other, and are very firmly bound together.

The ligaments which connect the bases of the four lateral metatarsal bones are *dorsal*, *plantar*, and *interosseous*. They are strong bands which pass between the non-articular portions of the basal parts of the bones, and they constitute the chief bonds of union.

Dissection.—**To bring the interosseous ligaments into view divide the dorsal ligaments and then forcibly separate the bases of the bones from one another.**

In addition to the ligaments which connect the basal ends of the metatarsal bones, the strong *transverse metatarsal ligament* of the heads of the metatarsal bones unites the distal extremities of the bones together. That ligament has been previously described (p. 399).

Joint Cavities of the Foot.—There are six separate joint cavities in connection with the tarsal, tarso-metatarsal, and intermetatarsal articulations, viz.—(1) The cavity between the posterior facets of the talus and calcaneus. (2) The calcaneo-cuboid joint cavity. (3) The cavity of the

PLATE XLIV

FIG. 200.—Radiograph of the Foot of an adult.

PLATE XLV

FIG. 201.—Radiograph of the Foot of a Child 11 years old.

PLATE XLVI

FIG. 202.—Radiograph of the Foot of a Child 6 years old.

Note (1). That the ossification of the epiphysis of the calcaneus has just commenced and that there is no indication of the os trigonum (see Fig. 201).

(2) That the distal epiphyseal line of the fibula runs parallel with the upper border of the talus.

PLATE XLVII

Fig. 203.—Radiograph of the Foot of an Adult showing an occasional variation.

(Major A. W. Pirie.)

joint formed by the head of the talus, the navicular, the sustentaculum tali, the plantar calcaneo-navicular ligament, the navicular part of the bifurcate ligament and talo-navicular ligament. (4) The cavity of the naviculo-cuneiform articulation, which is prolonged forwards between the cuneiforms, and also between the cuboid and third cuneiform bones; that cavity extends beyond the tarsus, and is continuous with the cavity between the second and third metatarsal bones and the tarsus, as well as with the cavities of the joints between the bases of the second, third, and fourth metatarsal bones.[1] (5) A separate cavity lies between the first metatarsal and the first cuneiform. (6) A distinct cavity for the articulations between the cuboid and the lateral two metatarsal bones; this is prolonged distally into the joint between the bases of these two metatarsals.

Metatarso-phalangeal and Interphalangeal Joints.—The metatarso-phalangeal and interphalangeal joints of the foot are constructed on a plan which is practically identical with that met with in the cases of the corresponding joints of the hand. In the cases of the metatarso-phalangeal joints the slightly cupped bases of the first phalanges articulate with the rounded heads of the metatarsal bones. The joints so formed are of the condyloid variety and allow flexion, extension, abduction, adduction, and circumduction. The interphalangeal joints, on the other hand, are hinge joints, which permit only flexion and extension. In them there are two cup-shaped depressions at the proximal end of the distal bone, which fit against the condyles of the trochlear surface of the distal end of the proximal bone. In both the metatarso-phalangeal joints and the interphalangeal joints the articular surfaces on the distal bones of the joints are limited, strictly, to the proximal ends of the bones, but the articular surfaces on the distal ends of the proximal bones are more extensive and are prolonged for a considerable distance on the plantar surface of the distal end of each bone. The result of this arrangement is that when the joints are extended a considerable part of the convex articular surface of the proximal bone rests upon the plantar accessory ligament of the joint capsule,

[1] The lateral interosseous tarso-metatarsal ligament, which passes from the third cuneiform bone (frequently from the cuboid bone) to the base of the fourth metatarsal bone, separates the cavity between the fourth and fifth metatarsal bones and the cuboid from the general tarsal articular cavity.

or, in the cases of the metatarso-phalangeal joint of the great toe, and occasionally of some of the other toes also, upon the sesamoid bones developed in the plantar accessory ligament (Fig. 197). When the joints are flexed the proximal end of the distal bone moves to the plantar aspect of the distal end of the proximal bone, and the extremities of the distal bones are then covered only by the extensor tendons and the skin. When the joints are flexed, therefore, they are easily opened from the dorsal aspects by cutting transversely directly against the heads of the proximal bones. The dissector should open one or more joints in that manner.

Each joint possesses the following ligaments:

Capsula articularis,
Ligamenta collateralia,
Ligamentum accessorium plantare.

Capsula Articularis.—The fibrous stratum of the articular capsule is deficient dorsally, and there the extensor tendons lie in direct relation with the synovial stratum which lines the interior of the fibrous stratum. At the sides the fibrous stratum is blended with the collateral ligaments, and on the plantar aspect with the plantar accessory ligament.

Ligamenta Accessoria Plantaria.—Each plantar accessory ligament is a dense fibrous plate which is firmly attached to the plantar aspect of the base of the distal bone of the joint, whilst it is loosely attached to the plantar aspect of the neck of the proximal bone of the joint. The collateral ligaments and the flexor sheath are fixed to its margins, and the transverse ligament of the heads of the metatarsal bones is attached to the plantar accessory ligaments of the metacarpo-phalangeal joints. The plantar accessory ligaments always move with the distal bones.

Ligamenta Collateralia.—The collateral ligaments are strong, thick triangular bands placed one on each side of each joint. The apex of the band is attached to the tubercle and the depression on the corresponding side of the head of the proximal bone of the joint, and the expanded base is attached to the side of the base of the distal bone and to the corresponding margin of the plantar accessory ligament.

Movements.—It has already been pointed out that at the *interphalangeal joints*, which are *hinge joints*, only the movements of flexion and extension are permitted, whilst the *metatarso-phalangeal joints*, which are *condyloid joints*, permit also abduction, adduction, and circumduction. At all the joints the movements of extension are produced by the extensors of the toes, but extension of the interphalangeal joints of the lateral four toes is produced also by the action of the lumbrical and interossei muscles, which act by means of their attachments to the extensor expansions. Flexion of the terminal interphalangeal joints of the lateral four is produced by the flexor digitorum longus; flexion of the first interphalangeal joint by the short flexor of the toes, aided by the long flexor of the toes. In flexion of the metatarso-phalangeal joints the long and short flexors play a part, but they are aided by the lumbrical and interossei muscles, and in the case of the little toe by the flexor digiti quinti brevis.

Flexion and extension of the interphalangeal joint of the great toe are produced by the long flexor and extensor respectively, and flexion and extension of the metatarso-phalangeal joint by the short flexor and extensor, aided by the long flexor and extensor. The dissector should remember that the lumbrical and interossei are flexors of the metatarso-phalangeal joints and extensors of the interphalangeal joints.

Abduction and adduction of the toes at the metatarso-phalangeal joints are produced by the interossei and the special abductors and adductors. The movements take place from and towards a line drawn longitudinally along the middle of the second toe. The lateral three toes are adducted by the plantar interossei, the great toe by the oblique and transverse adductors. The great toe and the little have each a special abductor muscle. The second toe is alternately abducted and adducted away from or towards its own middle line by the first and second dorsal interosseous muscles. The third toe is abducted by the third, and the fourth toe by the fourth dorsal interosseous muscle.

INDEX.

END OF VOL. I

Printed in Great Britain by R. & R. Clark, Limited, *Edinburgh.*

CUNNINGHAM'S MANUAL

OF

PRACTICAL ANATOMY

REVISED AND EDITED BY

ARTHUR ROBINSON

PROFESSOR OF ANATOMY IN THE UNIVERSITY OF EDINBURGH

SEVENTH EDITION

VOLUME SECOND

THORAX AND ABDOMEN

WITH 231 ILLUSTRATIONS, MANY OF WHICH ARE COLOURED

NEW YORK

WILLIAM WOOD AND COMPANY

EDINBURGH, GLASGOW, AND LONDON

HENRY FROWDE AND HODDER & STOUGHTON

1921

Printed in Great Britain by R. & R. Clark, Limited, *Edinburgh.*

1st Edition, 1896.
2nd Edition, 1903.
3rd Edition, 1906.
4th Edition, 1907.
5th Edition, 1912.
6th Edition, 1914.
6th Edition, *2nd Impression*, 1917.
6th Edition, *3rd Impression*, 1918.
7th Edition, 1920.
7th Edition, *2nd Impression*, 1921.

PREFACE TO THE SEVENTH EDITION

In this edition the general text has been revised, many new figures, representing dissections, sections and radiographs, have been introduced. The instructions for dissection have been printed in a distinctive indented type; in many cases they have been rewritten and in some cases amplified.

The latter changes, together with the additional figures, have caused so much increase of size that it has been deemed advisable to publish the book in three volumes. Vol. I.: Superior Extremity and Inferior Extremity; Vol. II.: Thorax and Abdomen; Vol. III.: Head and Neck.

As was the case in previous editions, I am indebted to Dr. E. B. Jamieson for many suggestions, for his invaluable help in the revision of the text and for the preparation of the Index.

My thanks are due to Dr. Robert Knox, to Major A. W. Pirie and to Major T. Rankin for the use of radiographs, which they very kindly prepared for me, and to Mr. J. T. Murray for the new drawings of sections and dissections.

ARTHUR ROBINSON.

Oct. 11, 1919.

CONTENTS

THORAX.

ABDOMEN.

MANUAL

OF

PRACTICAL ANATOMY.

THORAX.

THE dissection of the thorax is commenced on the *thirteenth* day[1] after the subject has been placed in the dissecting-room. By that time the upper limbs have been detached from the trunk.

In form, the thorax resembles a truncated cone. Anteriorly and posteriorly it is flattened; laterally it is full and rounded.

The cavity of the thorax is bounded—(1) *anteriorly*, by the sternum and costal cartilages; (2) *posteriorly*, by the twelve thoracic vertebræ and the intervening fibro-cartilages, together with the portions of the ribs which extend laterally from the vertebral column as far as the angles of the ribs; (3) *on each side* by the bodies of the twelve corresponding ribs, from their angles posteriorly to their anterior extremities anteriorly. The boundaries mentioned constitute the framework of the thorax, and can be studied on the skeleton, as well as upon the *part*, before the dissection is commenced.

The anterior wall of the thorax is so much shorter than the posterior wall that, during expiration, the upper margin of the sternum lies opposite the fibro-cartilage between the second and third thoracic vertebræ, and the lower end of the body of the sternum corresponds in level with the middle of the

[1] Saturdays and Sundays are not counted.

body of the ninth thoracic vertebra.[1] The bodies of the thoracic vertebræ project forwards into the cavity of the thorax, and greatly diminish its antero-posterior diameter in the median plane; but the backward sweep of the posterior portions of the ribs produces a deep hollow on each side of the vertebral column, for the reception of the most massive part of the corresponding lung (Fig. 5).

The superior aperture, or *inlet of the thorax*, is a narrow opening which is bounded by the first thoracic vertebra, the first pair of costal arches, and the manubrium sterni (Fig. 1). The plane of the superior aperture is very oblique; it slopes from the first thoracic vertebra forwards and downwards.

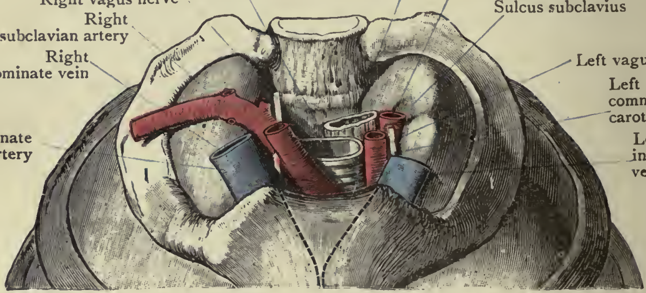


FIG. 1.—Cervical Domes of the Pleural Sacs, and parts in relation to them.

Through the aperture the apices of the lungs project upwards into the root of the neck, and, between them, the following structures either enter or leave the thorax:—the trachea, the œsophagus, the vagi, the phrenic nerves, the left recurrent nerve, the ganglionated sympathetic trunks, the thoracic duct, and the great arteries and veins which carry blood to and from the head and neck and the upper limbs.

The base or inferior aperture of the thorax is very wide, and is sometimes called the *outlet*. Anteriorly, it is bounded by the xiphoid process, and, posteriorly, by the twelfth thoracic vertebra. Between those points the lower margin of the thorax presents a curved outline. Starting from the sternum, it passes downwards, laterally, and backwards, as far as the

[1] This statement refers to average conditions. Not uncommonly the lower end of the body of the sternum is at the level of the tenth thoracic vertebra (Fig. 28).

tip of the eleventh costal cartilage; thence it proceeds upwards, backwards, and medially to the vertebral column. In the first part of its extent it is formed by the cartilages of the seventh, eighth, ninth, tenth and eleventh ribs, and in the second part by the lower border of the twelfth rib.

The lower margin of the thorax gives attachment to the diaphragm, a highly vaulted or dome-shaped musculo-tendinous partition, which intervenes between the cavity of the thorax above and that of the abdomen below. It forms a convex floor for the thorax, and a concave roof for the abdomen. By its upward projection it greatly diminishes the general vertical depth of the thoracic cavity (Figs. 9, 10, 11, 12).

As a result of this arrangement the peripheral margins of the inferior part of the thorax overlap the upper part of the abdomen, especially at the sides and behind.

But the diaphragm does not form an unbroken partition. It presents three large openings, by means of which structures pass to and from the thorax, viz.—(1) for the aorta, thoracic duct, and vena azygos; (2) for the œsophagus and vagi nerves; (3) for the inferior vena cava. Besides these there are other smaller apertures which will be mentioned later.

During life the movements of the thoracic wall produce alterations in the capacity of the thoracic cavity and play an essential part in the function of respiration. When inspiration takes place, that is when a "breath is taken," the sternum and the anterior parts of the ribs ascend and move forwards, with the result that the antero-posterior extent of the thoracic cavity is increased. At the same time, on account of the peculiarities of the articulations of the ribs, the lower borders of the majority of the ribs rotate outwards and the transverse diameter of the cavity is increased. The vertical extent of the thoracic cavity is increased by the contraction of the dome-shaped diaphragm. The central upper part of the dome which lies below the heart, and is tendinous, remains relatively stationary but the muscular peripheral parts contract. As they contract and pass from a more curved to a less curved position, they press down the contents of abdomen and distend the abdominal walls; consequently, as the floor of the thorax descends, the vertical extent of its cavity is increased.

As the cavity of the thorax is entirely enclosed, an increase of its extent tends to produce a vacuum in its interior, but if the student will close his nose and mouth and then try to "take a breath" he will find that the diaphragm and the muscles which move the ribs are not competent to create a vacuum in the thorax, and nothing but an abortive inspiratory movement is possible. Under ordinary circumstances, however, as the walls of the thorax move in such a manner as to increase the size of the cavity, atmospheric pressure (15 lbs. to the square inch) forces air through the air passages into the distensible lungs, enlarging them as the thoracic cavity increases in size, so that they fully occupy the expanding space and no vacuum is formed.

In inspiration, therefore, the cavity of the thorax increases in extent, and the increased area is occupied mainly by air forced into the elastic lungs, but partly also by blood which flows into the great veins of the thorax. In expiration, when the contraction of the muscles which raise the sternum and ribs ceases, those bones return to their original positions and the antero-posterior and transverse extents of the thorax decrease. Simultaneously, the contraction of the diaphragm having ceased, the tonicity of the abdominal muscles forces the abdominal viscera back to their original positions, so restoring the convexity of the diaphragm and diminishing the vertical extent of the thoracic cavity. The combined effect of the descending sternum and ribs, the ascending abdominal viscera, forced upwards by the abdominal muscles, and the elasticity of the lungs, overcomes the atmospheric pressure and air is forced out of the lungs, or in other words the "breath goes out"—that is, *expiration* takes place.

The two parts of the respiratory movement, the thoracic part, produced by the movements of the ribs and sternum, and the abdominal part, due to the action of the abdominal muscles, may take place together, or independently, producing then, respectively, "thoracic respiration" and "abdominal respiration."

The student should study the movements carefully, both on himself and on his friends.

THORACIC WALL.

Two days at least should be devoted to the dissection of the thoracic wall.

In addition to the osseous and cartilaginous framework, the walls of the thorax are built up partly of muscles, and partly of membranes, and in connection with those there are numerous nerves and blood-vessels.

Muscles, . .	External intercostals. Internal intercostals. Transversi thoracis. Subcostals.
Membranes, . .	Anterior intercostal membranes. Posterior intercostal membranes. Pleural membranes (parietal parts).
Nerves and Arteries,	Intercostal nerves. Aortic intercostal arteries. Superior intercostal arteries. Internal mammary arteries.

As the thorax may be the first "part" that the student dissects it is important, before he commences work, that he should have a clear idea of the constitution of a typical spinal nerve. Every spinal nerve is attached to the spinal medulla (*spinal cord*) by two *roots*, an *anterior root* and a *posterior root* (Fig. 2). The posterior root has a swelling upon it which is called a ganglion; the anterior root is non-ganglionated. As the roots leave the vertebral canal through an intervertebral foramen they unite to form a *trunk*. Immediately after its exit from the intervertebral foramen the trunk divides into an *anterior ramus* and a *posterior ramus* (Fig. 2), of which the anterior ramus is, with few exceptions, much the larger. Each posterior ramus divides into a *medial branch* and a *lateral branch*. Each anterior ramus divides into a lateral branch and an anterior or ventral branch.

Every anterior root consists of nerve fibres which spring from nerve cells in the spinal medulla and pass to the muscle fibres of various muscles. They carry motor impulses to the muscles. Each posterior root consists of nerve fibres passing to and from the nerve cells of the ganglion of the posterior root. The posterior root fibres carry sensory impulses, such as cold, heat, pain, etc. The sensory impulses pass through the cells of the ganglion of the posterior root and then onwards to the spinal medulla.

The trunk of every spinal nerve, therefore, contains both *motor* or *efferent* and *sensory* or *afferent nerve fibres*, and the posterior and anterior rami into which it divides also contain both sets of fibres. The branches of the rami may contain either both sets of fibres or only one or the other set. Eventually, however, the peripheral parts of the fibres conveying impulses from and those conveying impulses to the spinal medulla separate from one another. The fibres which convey impulses from the spinal medulla become the motor nerves which end in the muscle fibres, whilst the fibres which

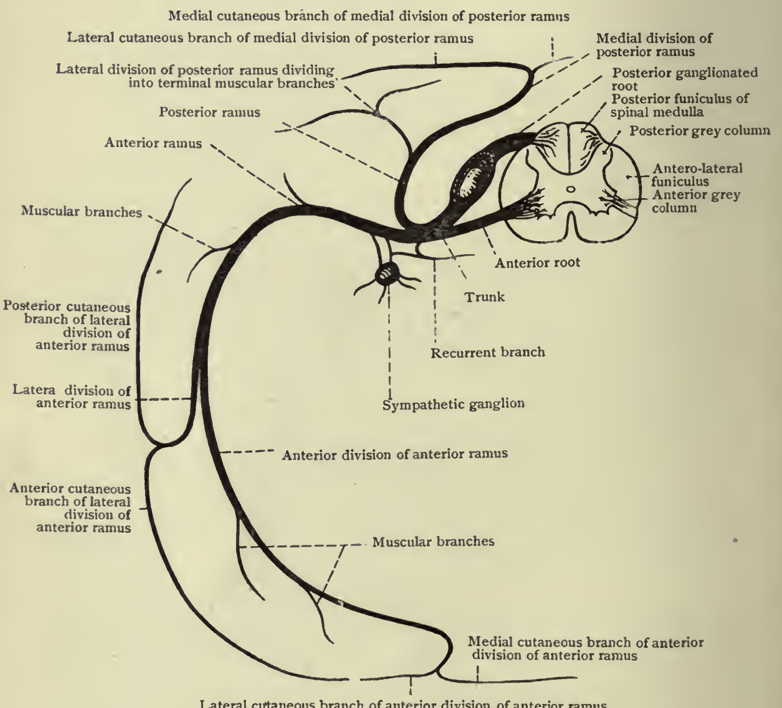


FIG. 2.—Diagram of the Spinal Nerve. Note that the medial division of the posterior ramus is represented as distributed to skin, whilst the lateral division terminates at a deeper level in muscle; in some situations the reverse condition occurs. The medial and lateral divisions of all posterior rami supply muscles.

convey sensory impulses only are the sensory nerve fibres. The sensory nerve fibres which convey sensory impulses from the skin are termed *cutaneous nerves*.

In the region of the thorax the branches which become cutaneous are the medial branches of the posterior rami of the upper six thoracic nerves and the lateral branches of the posterior rami of the lower six; the lateral branches of the anterior rami and the anterior ends of the anterior branches.

The cutaneous branches of the posterior rami have already been removed by the dissectors of the extremities, but the dissector of the thorax will find remnants of the lateral and anterior branches of the anterior rami of the thoracic nerves on the lateral and anterior aspects of the wall of the thorax where they appear as lateral and anterior cutaneous nerves.

The upper six anterior cutaneous nerves on each side, the accompanying perforating branches of the internal mammary artery, and the lateral cutaneous nerves which have been left in position by the dissectors of the superior extremity and the abdomen, together with portions of certain muscles of the superior extremity and the abdominal wall which are still attached to the thoracic wall, must be identified and examined before the dissection of the thoracic wall is commenced.

The anterior cutaneous nerves and the perforating branches of the internal mammary artery will be found at the sternal ends of the intercostal spaces piercing the pectoralis major. The lateral cutaneous nerves lie along the mid-axillary line, where they appear between the digitations of the serratus anterior and the obliquus externus.

The remnants of muscles to be examined are, from before backwards, the *pectoralis major*, attached to the sternum and the cartilages of the upper six ribs; the *pectoralis minor*, attached to the sternal extremities of the bony parts of the third, fourth, and fifth ribs; and the *serratus anterior*, attached to the upper eight or nine ribs, along a line extending from the anterior to the posterior axillary margin. Towards the lower margin of the chest lie:—the *rectus abdominis*, attached to the xiphoid process and the cartilages of the fifth, sixth, and seventh ribs; the *obliquus externus*, attached to the lower eight ribs, interdigitating with the serratus anterior and the latissimus dorsi; and the *latissimus dorsi*, attached to the lowest three or four ribs.

Dissection.—After their attachments have been verified remove the remnants of the muscles of the superior extremity and abdomen so as to lay bare the costal arches and the external intercostal muscles and membranes, but preserve the cutaneous nerves and the accompanying vessels. Clean the external intercostal muscles from behind forwards and note that in the upper spaces they are not prolonged between the costal cartilages, but terminate at or near the sternal ends of the bony parts of the ribs; the intervals between the muscles and the sternum are occupied by membranes, the *anterior intercostal membranes*,[1] which cover the anterior parts of the internal intercostal muscles.

Musculi et Membranæ Intercostales.—The intercostal muscles and membranes occupy the eleven intercostal spaces on each side. In each space there are two strata of muscular fibres—a superficial and a deep. The superficial layer of muscular fibres is called the *external intercostal muscle*, and the deep layer is called the *internal intercostal muscle.*

Musculi Intercostales Externi.—Numerous tendinous fibres are intermingled with the muscle fibres of the external intercostal muscles, and both the muscle fibres and the tendinous fibres are directed obliquely downwards and forwards from the lower border of the rib above to the upper border of the rib below. The muscles do not extend farther forwards, in the various spaces, than the region of union of the bony parts with the cartilaginous parts of the costal arches. In many cases, especially in the upper spaces, they do not reach so far. When the muscular fibres stop, the tendinous fibres are prolonged onwards to the sternum in the form of a membrane which is called the *anterior intercostal membrane.* The external intercostal muscles of the lower two spaces are exceptions to this rule. They extend forwards to the extremities of the spaces. Posteriorly, the muscles extend as far as the tubercles of the ribs, but that is a point which cannot be satisfactorily demonstrated at the present stage of dissection.

Dissection.—To bring the internal intercostal muscles into view it is necessary to reflect the external intercostal muscles, and also the anterior intercostal membranes. Divide two or more of the muscles and membranes along the lower borders of the spaces in which they lie, and throw each muscle and membrane upwards, but avoid injury to the intercostal vessels, which lie in the space between the external and internal intercostal muscles, and to the lateral branches of the intercostal nerve of the space.

[1] The anterior intercostal membranes are sometimes called anterior intercostal ligaments, but such terminology is not justified either by their position or constitution.

Musculi Intercostales Interni.—The internal intercostal muscles, laid bare by the dissection described, will be seen to be similar in their constitution to the external muscles. The fibres, however, run in the opposite direction—viz., from above, obliquely downwards and backwards. Superiorly, each is attached to the inner surface of the upper rib, immediately above the costal groove; inferiorly, it is attached to the inner surface of the lower rib, close to the upper margin. The internal intercostal muscles are prolonged forwards to the sternum. Posteriorly, they extend to the angles of the ribs. The *posterior intercostal membranes* extend from the vertebral column to the posterior borders of the internal intercostals, where they become continuous with the fascial layer between the external and internal intercostal muscles. They will be seen when the thorax is opened.

If the internal oblique muscle of the abdomen has not been removed, the dissector should note that the anterior fibres of the lowest two internal intercostal muscles become continuous with the fibres of that muscle.

The lateral and anterior cutaneous branches of the intercostal nerves have already been found, but the main parts of the trunks of the nerves are concealed under cover of the lower borders of the ribs, and a little dissection is necessary to expose them and the intercostal arteries and veins which lie, at still higher levels, under cover of the ribs.

Dissection.—The intercostal nerves and vessels should be dissected in two or three spaces. If the arteries are not injected it may be difficult or impossible to display them in the anterior parts of the spaces, but the posterior parts of the intercostal branches of the aorta and of the subclavian artery will easily be found later, after the thorax is opened (see pp. 33-35). First find the lateral cutaneous branch of an intercostal nerve, preferably that of the third, fourth, or fifth intercostal space. It will serve as a guide to the trunk of the nerve. Follow the lateral cutaneous branch to the lower border of the rib which bounds the space above, then take the bone forceps and cut away the lower border of the rib until the origin of the lateral cutaneous branch from the trunk of the nerve is found. When the trunk of the intercostal nerve has been secured, follow it backwards as far as possible, removing the lower part of the rib which covers it, and, at the same time, clean the intercostal artery and vein which lie above it, if they can be found. Next follow the trunk of the nerve forwards beyond the origin of the lateral cutaneous branch. About midway between the vertebral column and the sternum it leaves the artery and enters the substance of the internal intercostal muscle, whilst the artery continues forwards on the internal intercostal muscle to anastomose with an intercostal branch of the internal mammary artery. Follow the nerve through the internal intercostal muscle. It reaches the deep surface of the muscle at the junction of the cartilage with the bone of the rib and then passes onwards either between the internal intercostal and the pleura or between the internal intercostal and the transversus thoracis muscle to the internal mammary artery, which descends behind the costal cartilages about 13 mm. (half an inch) from the margin of the sternum. Follow the nerve across the front of the internal mammary artery and note that it terminates as an anterior cutaneous nerve. As the intercostal nerve is cleaned small branches will be found passing from it to supply the intercostal

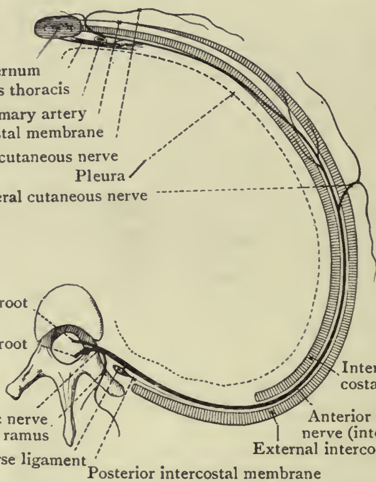


FIG. 3.—Diagram of one of the Upper Intercostal Nerves.

muscles. If one of the lower six intercostal nerves is followed it will be found to pass out of the anterior part of the intercostal space, into the abdominal wall, where it will be traced by the dissector of the abdomen.

Nervi Intercostales. — The intercostal nerves are the anterior rami of the upper eleven thoracic nerves on each side. Each nerve gives a white branch to and receives a grey branch from a ganglion of the sympathetic trunk, and then enters the corresponding intercostal space. At the angle of the ribs it passes into the interval between the external and internal intercostal muscles and runs forwards, between the muscles, to about the mid-axillary line. Then it begins to pass obliquely through the internal intercostal muscle, reaching the internal surface of the muscle at the junction of the bone with the cartilage of the rib; from that point it continues towards the median plane, lying in the cases of the first two nerves between the internal intercostal muscle and the pleura, and in the cases of the third, fourth, and fifth, between the internal intercostal muscle and the transversus thoracis. About 13 mm. from the sternum it crosses in front of the internal mammary vessels; then, it turns forwards, and after piercing the internal intercostal muscle, the anterior intercostal membrane, the pectoralis major muscle, and the deep fascia, it enters the superficial fascia of the thorax as an anterior cutaneous nerve.

The above description holds good for the upper five nerves only; after the lower six nerves have reached the deep surfaces of the corresponding internal intercostal muscles they leave the anterior ends of the intercostal spaces and enter the wall of the abdomen. As they leave the thoracic wall the upper four of the six pass posterior to the upturned costal cartilages, and all six pass between interdigitating slips of the diaphragm and the transversus abdominis. Then they continue towards the median plane between the transversus abdominis and the obliquus internus, enter the sheath of the rectus abdominis, turn forwards, and, after piercing the rectus abdominis, the anterior wall of its sheath, and the deep fascia, they enter the superficial fascia as anterior cutaneous nerves of the abdomen.

The dissector of the thorax traces the lower intercostal nerves only as far as the anterior ends of the intercostal spaces. The dissector of the abdomen has displayed them in the wall of the abdomen.

Whilst the intercostal nerves are between the intercostal muscles each gives off branches to the muscles between which it lies, and a lateral cutaneous branch. The *lateral cutaneous branch* pierces the external intercostal muscle and then passes, according to its position, either between digitations of the serratus anterior or external oblique muscles and divides into anterior and posterior branches which are distributed to the skin. The first intercostal nerve does not give a lateral cutaneous branch. Nor does it become cutaneous at its termination. The lateral cutaneous branch of the second is distributed to the arm as the *intercosto-brachial* nerve. The lateral cutaneous branches of the lower intercostal nerves supply muscular twigs to the digitations of the external oblique muscle of the abdomen. The anterior continuations of several of the intercostal nerves give additional muscular twigs to the adjacent muscles. The fourth, fifth, and sixth supply the transversus thoracis, and the lower six supply the internal oblique, the transversus abdominis, and the rectus abdominis muscles.

Dissection.—If the dissector has not been successful in displaying the intercostal vessels in the spaces in which he has dissected the nerves an attempt should be made to dissect out the vessels in a fresh space, but a satisfactory demonstration of the vessels in the anterior parts of the spaces will not be possible unless the subject has been well injected.

Arteriæ Intercostales.—In each intercostal space *one* artery is found passing *dorso-ventrally*; and in each of the upper nine intercostal spaces *two* anterior intercostal arteries run *ventro-dorsally.*

In the uppermost two spaces the vessels which run dorso-ventrally are derived from the *superior intercostal* division of the costo-cervical branch of the subclavian artery; in the lower nine spaces they spring directly from the aorta, and are called the *aortic intercostal arteries.*

The *anterior intercostal arteries* of the upper six spaces are branches of the internal mammary artery, whilst those of the seventh, eighth, and ninth spaces arise from the musculo-phrenic artery. There are no anterior intercostal arteries in the last two spaces.

The intercostal vessels are distributed, for the most part, between the two muscular strata. From the angles of the ribs onwards to a point midway between the vertebral column and sternum, the *aortic intercostal arteries* lie under shelter of the lower margins of the ribs which bound the spaces superiorly, at a higher level than the corresponding nerves and below the accompanying vein. Midway between the vertebral column and the sternum each aortic intercostal artery divides into two branches, which pass forwards in relation to the upper and lower margins of the intercostal space, and either the trunk or the upper branch gives off a twig which accompanies the lateral cutaneous nerve. The lower two aortic intercostal arteries are carried onwards into the abdominal wall. The branches of the *superior intercostal artery* are disposed in a manner similar to the upper aortic intercostal vessels.

The *anterior intercostal arteries* are two in number for each space, except the last two. At their origins they lie under cover of the internal intercostal muscles, and they run laterally in relation to the upper and lower margins of the ribs bounding the spaces. After a short course they pierce the internal intercostal muscles, and end by anastomosing with branches of the aortic and superior intercostal arteries.

The *anterior intercostal veins* accompany the corresponding arteries; the lower ones end in the musculo-phrenic vein, and the upper in the venæ comites of the internal mammary artery.

The veins which accompany the aortic intercostal arteries and the branches of the superior intercostal artery will be traced to their terminations after the thorax has been opened (see p. 33).

Dissection.—The dissector should next proceed to remove the intercostal muscles and membranes from all the intercostal spaces. This dissection must be done with great care, for immediately subjacent to the internal intercostals and the ribs is the delicate pleural membrane which lines the inner surface of the chest wall. The membrane must not be injured or detached from the deep surfaces of the ribs during this stage of the dissection. As the internal intercostal muscles are removed, the anterior perforating branches of the internal mammary and musculo-phrenic arteries, and the anterior cutaneous nerves, must be preserved.

When the muscles are removed the internal mammary artery, with its two accompanying veins, will be seen behind the costal cartilages, about half an inch from the side of the sternum (Figs. 20, 27). Clean those vessels in the intervals between the cartilages, and note the small *sternal lymph glands* which lie beside them. Each internal mammary artery ends by dividing into superior epigastric and musculo-phrenic terminal branches in the interval between the sixth and seventh rib cartilages. Most likely that space will be so narrow that a view of the bifurcation cannot be obtained. If that is the case, pare away the edges of the cartilages or, if necessary, remove a portion of the sixth cartilage completely. The muscle posterior to the internal mammary artery is the transversus thoracis (O.T. triangularis sterni). Endeavour to define its slips in the intervals between the costal cartilages.

The dissector should note, as an important practical point, that, towards the lower and anterior parts of the thorax, the pleural sac is not prolonged downwards to the lowest limit of the recess between the diaphragm and the costal arches. Indeed, in the mid-axillary line, and along the costal arch on each side, it will be found to fall considerably short of that limit. Consequently, when the internal intercostal muscles are removed from the anterior parts of the lower intercostal spaces, the dissector will come down directly upon the diaphragm (Fig. 9).

The fibres of the diaphragm, in the region in question, correspond somewhat in their direction with those of the internal intercostal muscles, and it is no uncommon occurrence for the student to remove them, and thus expose the peritoneum, under the impression that he has laid bare the pleura. When the dissection of the lower intercostal spaces is properly executed a strong fascia will be exposed as the internal intercostal muscles are removed.

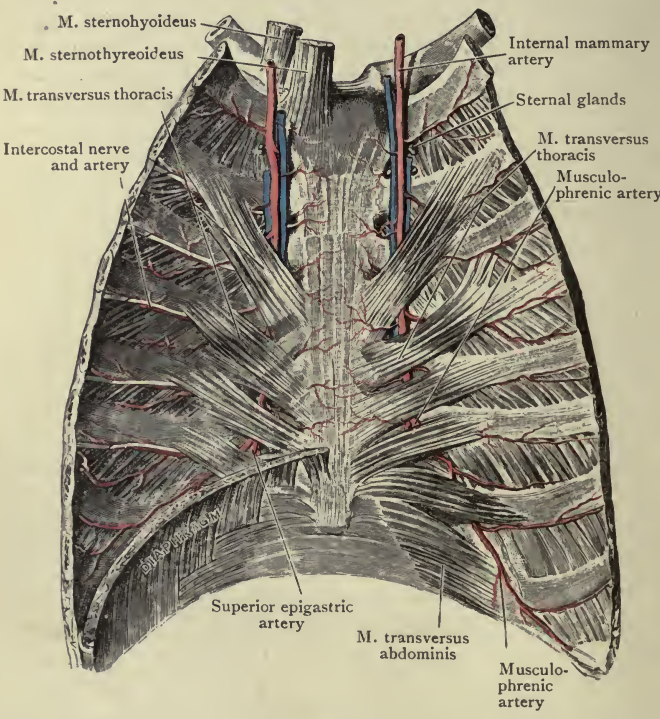


FIG. 4.—Dissection of the posterior surface of the Anterior Wall of the Thorax.

It passes from the surface of the diaphragm to the costal pleura and holds the latter in position. Preserve it for further examination.

Arteria Mammaria Interna.—Each internal mammary artery arises, in the root of the neck, from the first part of the corresponding subclavian artery. It enters the thorax by passing downwards, posterior to the sternal end of the clavicle and the cartilage of the first rib, and it descends to the interval between the sixth and seventh costal cartilages, where it ends by dividing into the *superior epigastric* and the *musculo-phrenic branches* (Figs. 4, 27).

Placed anterior to the internal mammary artery are the upper six costal cartilages, with the intervening internal intercostal muscles and anterior intercostal membranes. The intercostal nerves cross anterior to it before they turn forwards to gain the surface. Posterior to the upper part of the artery is the pleura; and the transversus thoracis intervenes between the lower part of the artery and the pleural sac.

The branches of the internal mammary artery are two terminal and a large number of small collateral twigs—

1. The anterior intercostal, . 2. The perforating, . .	to the thoracic parietes.
3. The pericardiaco-phrenic, 4. Mediastinal and thymic, .	to parts in the interior of the thorax.
5. Superior epigastric, . 6. Musculo-phrenic, . .	the terminal branches.

The *anterior intercostal arteries* are supplied to the upper six intercostal intervals, and have been dissected already (p. 12). Two are given to each space: each pair may arise by a common trunk from the internal mammary stem.

The *perforating arteries* accompany the anterior cutaneous nerves. They reach the surface by piercing the internal intercostal muscles, the anterior intercostal membranes, and the pectoralis major muscle. One, or perhaps two, are given off in each intercostal space. In the female, those of the second, third, and fourth spaces attain a special importance, inasmuch as they are important arteries of supply to the mammary gland.

The *superior epigastric artery* passes between the sternal and costal origins of the diaphragm and enters the sheath of the rectus muscle of the abdominal wall.

The *musculo-phrenic artery* turns laterally and downwards, along the costal origin of the diaphragm and behind the rib-cartilages. Opposite the eighth costal cartilage it pierces the diaphragm and terminates on its abdominal surface. It gives off the *anterior intercostal arteries* to the seventh, eighth, and ninth intercostal spaces.

Vena Mammaria Interna.—Each internal mammary artery is accompanied in the greater part of its course by two venæ comites. At the upper part of the thorax the venæ comites of each artery end in a single internal mammary vein, which joins the corresponding innominate vein in the superior mediastinum. The terminations of the internal mammary veins will be seen when the contents of the superior mediastinum are dissected (see p. 66 and Figs. 4, 27).

Musculus Transversus Thoracis (O.T. **Triangularis Sterni**).—The transversus thoracis is a thin muscular layer placed on the deep surface of the sternum and costal cartilages. It arises from the posterior surface of the xiphoid process, the lower part of the body of the sternum, and from the medial ends of the fifth, sixth, and seventh costal cartilages, and it is continuous below with the transversus abdominis. Its fibres radiate in an upward and lateral direction, in the form of five slips, which are inserted into the deep surfaces and lower borders of the second, third, fourth, fifth, and sixth costal cartilages, close to their junction with the ribs (Fig. 4). It is supplied by the fourth, fifth, and sixth intercostal nerves, and probably facilitates expiration by assisting to depress the anterior parts of the ribs. It is supplied by the intercostal nerves.

In many cases the muscle is feebly developed, and does not show such wide connections. Upon its anterior aspect are placed the internal mammary artery and some of the intercostal nerves.

It is only a partial view of the muscle which is obtained in the present dissection, but it is not advisable to remove the costal cartilages to expose it further, as this would materially interfere with the subsequent display of the relations of other more important structures.

THORACIC CAVITY.

Before the dissection of the interior of the thorax is commenced it is necessary that the dissectors should have some general knowledge of the cavity and its contents. The shape and the boundaries have been studied already (p. 1), and it must now be understood that the cavity is divided into two lateral parts, right and left, by a median septum called *the mediastinum*, which extends from the sternum anteriorly to the vertebral column posteriorly, and from the upper aperture of the thorax above to the diaphragm below.

In the mediastinal septum lie the heart, enveloped in a fibro-serous sac called the pericardium; the great vessels passing to and from the heart, *i.e.* the pulmonary artery and veins, the aorta, and the vena cava superior; the œsophagus; the trachea and the commencements of the bronchi; the thoracic duct; the azygos, hemiazygos and accessory hemiazygos veins; the vagi and phrenic nerves; numerous lymph glands; all the structures mentioned are embedded in the areolar tissue of the septum which ensheaths them and binds them together whilst, at the same time, on account of its elasticity it allows the heart and vessels to dilate and contract. In addition there are the remains of the thymus gland which vary considerably in size at different periods of life. For convenience of description the mediastinum is divided into a *superior* and an *inferior portion*, by an imaginary plane which passes from the lower border of the manubrium sterni anteriorly, to the lower border of the fourth thoracic vertebra posteriorly; and the inferior mediastinum is subdivided into anterior, middle, and posterior portions. The *anterior mediastinum* is the part anterior to the pericardium; the *posterior mediastinum* is the part posterior to the pericardium; whilst the pericardium and the heart, with the great vessels, and portions of the phrenic nerves, with their accompanying vessels, lie in the *middle mediastinum* (Figs. 20, 21, pp. 50, 51).

The lateral portions of the thoracic cavity are known as the pleural spaces, though no such spaces exist, for each so-called space contains and is completely filled by the corresponding lung, which is surrounded by an invaginated serous membrane called the pleural sac. There are therefore two pleural sacs, and each is so disposed that it not only lines the chamber in which the lung lies, but is also reflected over the surface of the lung, so as to give it an external covering which is intimately connected with the pulmonary substance. Consequently, the wall of each pleural sac is separable into two portions, an investing or visceral part which covers the surface of the lung, and a lining or parietal part which clothes the inner surfaces of the boundary of each lateral part of the thoracic cavity. It must be clearly understood, however, that the two terms are applied merely to indicate different portions of a continuous membrane.

Each lung lies free in the pleural space, except along its medial surface, where it is attached to the heart by the pulmonary vessels; to the corresponding bronchial tube; and, by a fold of pleura, to the side of the pericardium.

The dissection which has already been made shows the pleura lining the deep surfaces of the costal arches and the internal intercostal muscles. That part is called the *costal pleura*, and it is part of the *parietal pleura*. The student must understand that the term costal pleura is applied only to that part of the parietal pleura which lines the costal part of the thoracic wall; the part which covers the mediastinum

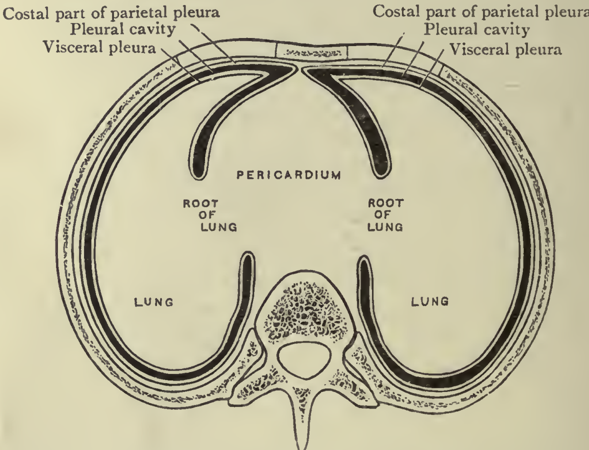


FIG. 5.—Diagrammatic representation of a cross section through the Thorax.

is called *mediastinal pleura*, the part which covers the upper surface of the diaphragm is the *diaphragmatic pleura*, and the part which projects into the root of the neck is spoken of as the *apical* or *cervical pleura*. Before the costal pleura can be more fully investigated, and before the remaining parts of the pleuræ and the lungs can be examined, further dissection is necessary.

Dissection.—The pleural membrane previously exposed by the removal of the contents of the intercostal spaces must now be carefully separated from the inner surfaces of the ribs by gentle pressure of the fingers. The separation should be carried anteriorly to the junction of the ribs with their cartilages and posteriorly as far as possible. When that has been done, the ribs, from the second to the eighth inclusive, must be divided, with bone forceps, at their junctions with their cartilages, and, at the same time, any fibres of the transversus thoracis which may be attached to them must be cut. *The first and the ninth ribs and those below the ninth must not be interfered with.* Afterwards the ribs, from the second to the eighth inclusive, must be divided as near their vertebral ends as possible and the separated portions removed. After the separated parts of the ribs are detached, remove any sharp spicules of bone from the cut ends of the remaining portions.

The outer surface of the costal part of the parietal pleura will then be exposed in the area from which the ribs have been removed, and the dissector should notice that it has the appearance of a fibrous membrane with a rough surface, the roughness being due to fragments of the connective tissue (endothoracic fascia) which connect it with the adjacent parts.

After the dissector has examined the outer surface of the pleura, he should divide the membrane by a vertical incision about midway between the anterior and posterior borders of the area exposed. At each end of the vertical incision a transverse incision must be made. One of the two flaps, so formed, must be thrown forwards, and the other backwards. The pleural sac will then be opened and the lateral surface of the lung, covered with the adherent visceral portion of the pleura, will be exposed.

The cavity of the sac and its relations to the mediastinal septum, to the diaphragm, and to the root of the neck, can now be explored with the fingers; and the borders, surfaces, and the root of the lung can be examined.

If the lungs are healthy and are not hardened with formalin they will shrink to one third of their original bulk as soon as the pleural sacs are opened.

Pleuræ.—There are two pleural sacs, a right and a left. They are serous sacs, and are therefore closed. After opening into the interior, the dissector should notice the difference between the rough outer surface of the wall of the sac and its smooth and glistening inner surface, and in order that he may thoroughly understand the relationship of the wall of the sac to the lung, and to the mediastinum and the wall of the thoracic cavity, he should follow the wall of the sac, with his fingers, at three different levels—(1) at the level of the third intercostal space, (2) at the level of the fifth costal cartilage, and (3) at the level of the manubrium sterni. He must trace the wall of the sac in the vertical plane also.

Commencing at the level of the third intercostal space, he should place his fingers on the surface of the lung and follow it forwards and medially until, behind the sternum, he reaches the sharp, anterior border, which should be pulled laterally; then, turning from the lung to the parietal pleura, he should place his fingers on the inner surface of the anterior flap and follow it medially. He will find, at a certain point posterior to the sternum, and to the left of the median plane, that his fingers cease to pass towards the opposite side but are carried backwards on the mediastinal part of the parietal pleura, along the lateral boundary of the mediastinum, until they come to the big blood-vessels and the air tube of the lung, which collectively form its root. Along the front of the vessels his fingers will now pass laterally, following the reflection of the pleura on the front of the vessels, to the medial surface of the lung, and then anteriorly to its anterior border. Round the anterior border they will arrive at the lateral surface of the lung; along that surface they will pass to the posterior border and thence forwards along the posterior part of the medial surface to the posterior surface of the root, where they will feel, distinctly, the hard outline of the bronchus. Following the posterior surface of the root medially, they will reach the posterior part of the lateral boundary of the mediastinum, along which they will pass backwards to the vertebral column, and thence laterally along the posterior parts of the ribs, and finally forwards along the inner surface of the posterior flap to its anterior margin.

If the dissector has followed the instructions given above he cannot have failed to recognise that the pleural sac is invaginated by the lung, which in its growth laterally from the mediastinal septum has invaginated and expanded a part of the medial wall of the sac. The dissector should now examine a transverse section of a hardened thorax, or, if that is not available, the diagram on p. 18. The study of either will convince him that the lung, carrying the invaginated part of the wall of the pleural sac on its surface, has expanded until it has practically obliterated the cavity of the sac; and he will understand that the invaginated pleura on the surface of the lung, which is called the *visceral pleura*, is everywhere in close apposition with the non-invaginated portion, which is termed the *parietal pleura*; all that intervenes between the two portions, in ordinary circumstances during life, is a thin stratum of fluid, sufficient to lubricate the surfaces and prevent friction during the movements of the lung and the chest wall.

After the dissector has grasped the facts noted above he should follow the inner surface of the pleura in the transverse plane at the level of the fifth costal cartilage, that is, below the level of the root of the lung. At that level he will find that the parietal pleura covering the lateral surface of the mediastinal septum is connected with the visceral pleura on the medial surface of the lung by a thin fold called the pulmonary ligament (O.T. ligamentum latum pulmonis). The ligament consists of an anterior and a posterior layer, which correspond, respectively, with the layers on the front and the back of the root of the lung, but they are in contact with each other at the level of the fifth rib, on account of the absence of the great blood-vessels and air tube of the lung. The *pulmonary ligament* extends from the mediastinum to the medial surface of the lung, and from the root of the lung above, to within a short distance from the diaphragm below. Its medial, lateral, and upper borders are attached respectively to the mediastinal septum, the lung, and the lower border of the lung root, and are continuous with the pleura covering each, but its lower border is free. When the dissector has satisfied himself regarding the nature and the attachments of the pulmonary ligament, he should trace the pleura in the horizontal plane at the level of the manubrium sterni, that is, above the level of the root of the lung. There he will find that the medial wall of the sac is not reflected on to the lung, but that it passes backwards along the surface of the mediastinal septum, from the sternum anteriorly to the vertebral column posteriorly, and thence laterally and forwards to the sternum, in an unbroken circle. In the same way he will be able to trace the visceral pleura in a similar but smaller unbroken circle around the upper part of the lung.

Having traced the pleura in three horizontal planes the dissector must next trace it in the vertical plane, first around the lung, and then around the wall of the thorax. Commencing with the lung, the fingers should be passed along the anterior border to the apex, thence, down the thick posterior border, to the base, and forwards, across the concave base, to the anterior border. By doing this the dissector will again demonstrate to himself the fact that the lung is ensheathed in visceral pleura. Next, placing his fingers on the inner surface of the parietal pleura behind the costal cartilages, he should carry them upwards towards the head, and he will find that they pass upwards into the root of the neck for a distance of from one to two inches above the level of the anterior part of the first rib, but, on account of the oblique position of the rib, only to the level of its neck posteriorly. The apex of the sac, therefore, lies in the root of the neck, and by carefully palpating its inner surface the dissector will be able to distinguish the subclavian artery, which passes across its anterior surface below the highest point, and, possibly, he may be able to locate the internal mammary and costo-cervical arteries (O.T. superior intercostal) (Fig. 6). The first descends from the subclavian trunk anterior to the apex of the sac, and the second passes first

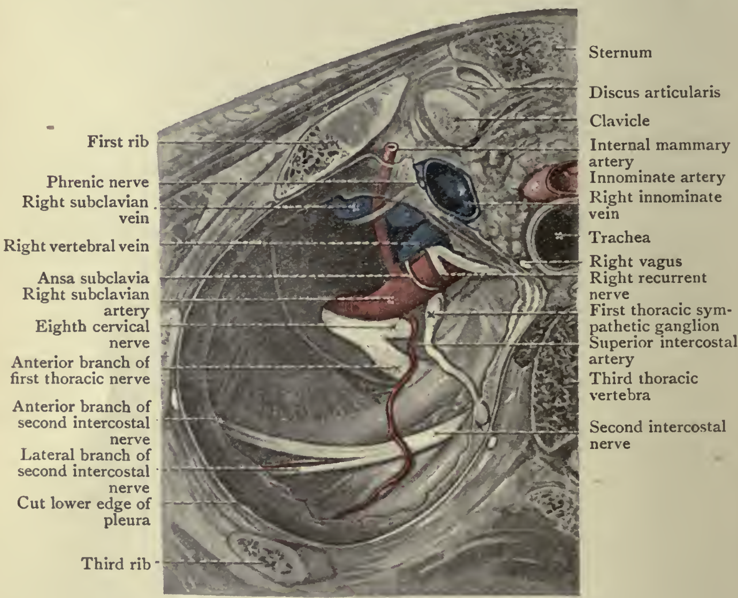


FIG. 6.—Structures in relation with the apex of the pleural sac, seen from below.

upwards to the apex and then backwards above it. After the dissector has examined the position and relations of the apex of the sac he should follow its posterior wall downwards, just lateral to the line of the vertebral column. If he is dealing with a subject in good condition, he will find that he can pass his fingers downwards to the lower border of the twelfth rib, where they will be carried forwards on to the diaphragm and over its surface to the anterior wall of the thorax. If the dissector carries out the examination of the pleural sac in a thorough manner, and if he has appreciated the significance of the arrangements found at different levels, he will have repeatedly convinced himself that the lung, carrying the blood-vessels and air tube with it, has during its development, invaginated a portion of the lower part of the medial wall of the pleural sac, and has then expanded anteriorly, posteriorly, upwards and, to a certain extent, downwards, beyond the margins of the aperture of invagination; the position of the aperture being indicated by the root of the lung and the line of attachment of the pulmonary ligament. The portion of the wall of the pleura which is invaginated by the lung is represented by: (1) the visceral pleura, (2) the layers covering the root of the lung, and (3) the pulmonary ligament.

Before each lung is removed the dissectors should note that its anterior margin does not extend so far forwards, and the inferior margin does not extend so far downwards, as the corresponding part of the pleura. The portions of the pleura unoccupied by the lung are called the pleural sinuses. The sinus along the anterior margin of the pleura is the *costo-mediastinal sinus*, and that along the lower margin, the *phrenico-costal sinus*. The walls of the sinuses are separated by a thin layer of pleural fluid, and the margins of the lungs enter the sinuses during inspiration and recede from them during expiration.

In the event of the lungs not having been hardened *in situ* by formalin injection, the dissectors may, with the consent of the dissectors of the head and neck, introduce the nozzle of the bellows into the cervical part of the trachea and inflate the lungs with air. A truer conception of the size and the form of the organs will then be obtained, and a demonstration will be afforded of their high elasticity, and of their connection with the wind-pipe.

Dissection.—After the dissector has completed the general examination of the walls of the pleural sac, he should pull the anterior margin of a lung laterally to expose its medial surface, the front of the root and the front of the pulmonary ligament; then he should divide the root and the pulmonary ligament, from above downwards, close to the medial surface of the lung. The lung, thus set free, is to be removed from the thorax, wrapped in a cloth damped with preservative solution, and placed aside for future study. The opposite lung must be removed in a similar manner, and then the margins of the pleural sacs must be examined and their positions, relative to the chest wall, must be noted.

When both lungs have been removed the dissector should introduce one hand into each pleura, and placing an index finger in each apex, he should note that the apex is situated about one inch above the medial third of the clavicle, a fact which he can demonstrate with the aid of his partner on the opposite side, who should hold two macerated clavicles in their proper positions. The apices of opposite sides, therefore, are some distance apart, and are separated from each other by the structures occupying the median part of the neck; *i.e.* the trachea, the œsophagus, and the great vessels passing to and from the head. As the anterior margins of the pleuræ are traced downwards from the apices they will be found to converge, passing behind the sterno-clavicular joints and coming into apposition at the lower border of the manubrium, immediately to the left of the median plane. Traced further downwards, the anterior margins remain in apposition, the right often overlapping the left and both inclining slightly to the left, as far as the level of the fourth costal cartilages. From the fourth cartilage the anterior margin of the right sac continues to descend, still with a slight inclination to the left, till it reaches the xiphoid process, where it becomes continuous with the inferior margin. The inferior margin turns laterally, passing behind the xiphoid process and the cartilage of the seventh rib; it then crosses the junction of the bone and cartilage of the eighth rib, and reaches the level of the tenth rib in the mid-axillary line; turning posteriorly, it crosses the eleventh and twelfth

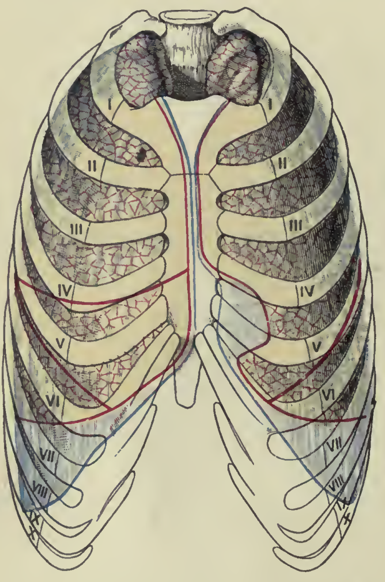


FIG. 7.—Diagram to show the relation of the lungs and the pleural sacs to the anterior thoracic wall. The lungs are depicted in red, and the pleural sacs in blue.

ribs, and just below the middle of the twelfth it becomes continuous with the posterior margin, which ascends along the line of the angles of the ribs to the apex. On the left side, at the level of the fourth costal cartilage, the anterior margin of the left pleura turns away from the median plane, for a variable distance, passing behind the fifth costal cartilage at

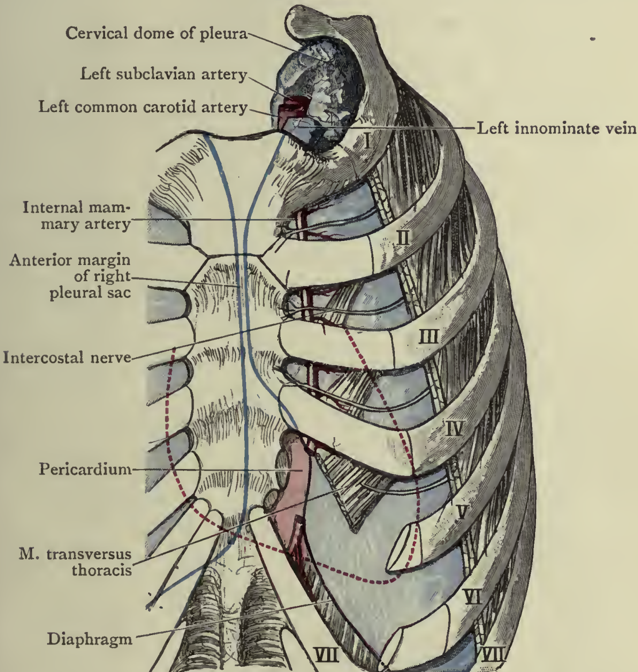


FIG. 8.—Diagram to show the parts which lie anterior to the pericardium and heart. The outline of the heart is indicated in red by a dotted line, and the anterior margins of the pleural sacs are represented by blue lines.

the margin of the sternum, or even 25 mm. (one inch) more laterally; it then descends to the lower border of the sixth cartilage, where it becomes continuous with the lower margin of the pleura, which passes laterally and backwards along the lower border of the sixth cartilage, across the medial end of the sixth space, and across the seventh cartilage to the junction of the cartilage and bone of the eighth rib. The remainder of its course and the position of its posterior margin are the same as on the right side.

The details given regarding the levels of various parts

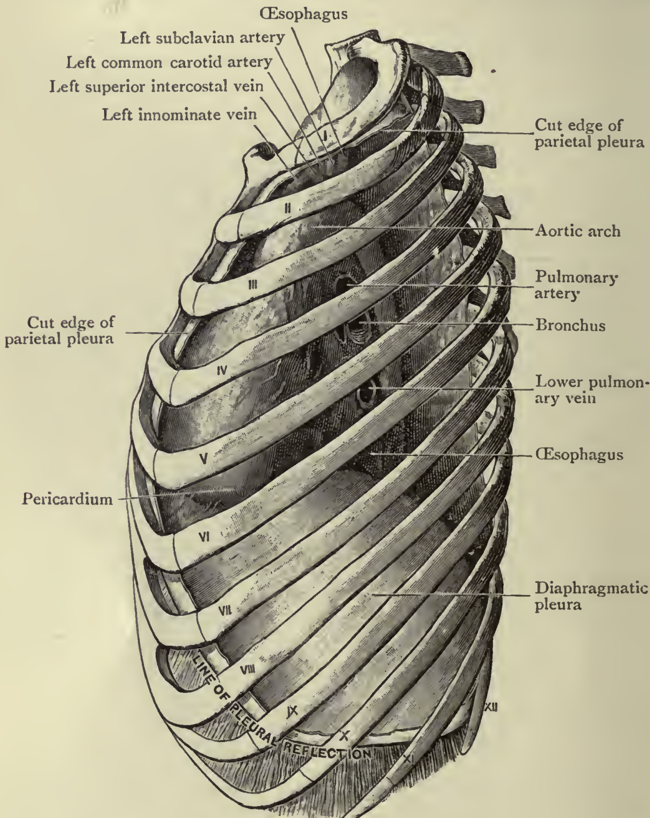


FIG. 9.—Left Pleural Sac, of a subject hardened by formalin injection, opened into by the removal of the costal pleura. The left lung also has been removed so as to display the mediastinal pleura. The line along which the pleura is reflected from the diaphragm on to the thoracic wall is exhibited.

of the inferior borders of the lungs and pleuræ are not easily remembered, and it will be sufficient if the levels on three definite lines are kept in mind. The three lines are the parasternal, the mid-axillary, and the scapular line.

The *parasternal line* is a vertical line, situated midway

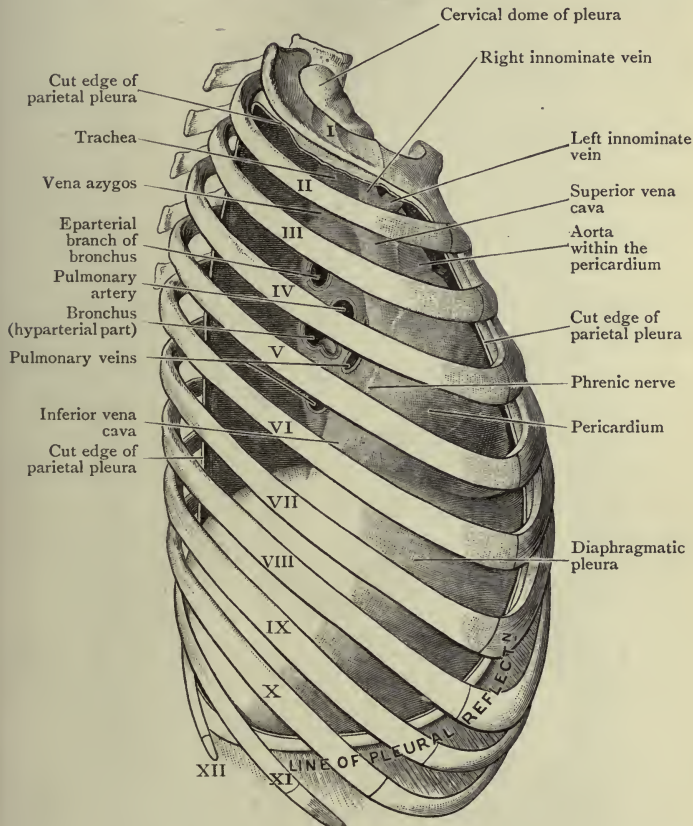


FIG. 10.—The Right Pleural Sac, in a subject hardened by formalin injection, opened into by the removal of the costal part of the parietal pleura. The right lung also has been removed to display the right mediastinal pleura. Note the line of diaphragmatic reflection of the pleura.

between the margin of the sternum and the lateral body line, which is a perpendicular projected vertically upwards, from the mid point between the anterior superior spine of the ilium and the symphysis pubis. The *mid-axillary line* needs no definition. The *scapular line* is a vertical dropped from

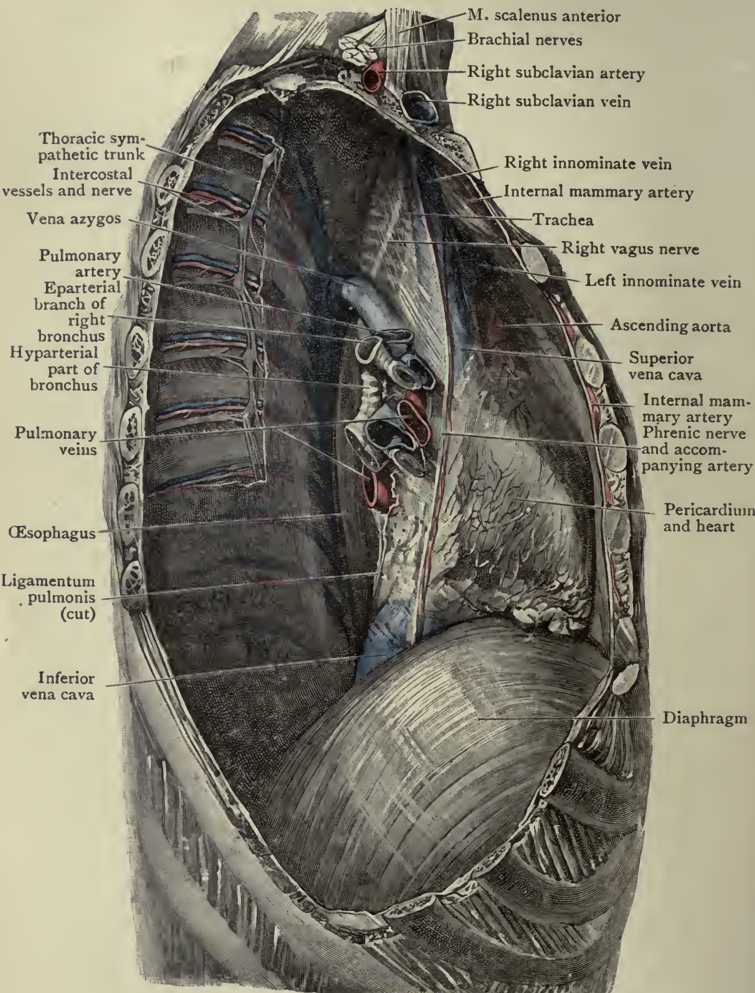


FIG. 11.—The Right Pleural Chamber opened up by the removal of its lateral wall. The lung has been taken away so as to expose the mediastinal wall of the pleural chamber. Several of the structures in the mediastinal septum are seen shining through the mediastinal pleura.

the inferior angle of the scapula when the arm is by the side. The lower margin of the lung lies at the sixth rib in the parasternal line, the eighth rib in the mid-axillary line, and the tenth rib in the scapular line. The lower margin of the pleura is roughly about one rib lower; it lies at the seventh rib in the parasternal line, the ninth rib in the mid-axillary line, and the eleventh rib in the scapular line. The points given are only approximate, but they are sufficient for most practical purposes, and are easily remembered. It should be noted that, on account of the obliquity of the ribs, a horizontal line drawn round the thorax at the level of the point where the parasternal line cuts the sixth rib will cut the eighth rib in the mid-axillary line and the tenth rib in the scapular line; but the inferior margin of the lung is not quite horizontal; on the contrary, it is slightly convex downwards; therefore, when the line indicating its position is drawn the convexity must be allowed for. Further, the student must not forget that the line of the lower margin of the pleura is fixed, but the lower margin of the lung varies in position, being highest at the end of expiration and lowest at the end of inspiration, and the amount of its possible excursion varies in different persons.

Keeping the above-mentioned points in mind, the student should mark out the margins of the pleural sacs on the living body, using himself and his friends for the purpose, until he can indicate them correctly, judging from the contour of the body alone and without feeling for the skeletal points.

After the dissector has made himself thoroughly conversant with the limits of the pleural sacs, he should examine the cut section of the root of the lung, and should endeavour to recognise, through the mediastinal part of the parietal pleura, the positions of the main constituent parts of the mediastinum. As these vary on the opposite sides, each side must be considered separately, and each dissector must make himself well acquainted with the conditions on both sides.

On the right side, in the posterior part of the face of the section of the lung root, at least two parts of the bronchial tube will be seen; an upper, which is the so-called eparterial bronchus, and a lower, the main stem of the right bronchus. Anterior to and between the two bronchi is the pulmonary artery, and more anteriorly, and at a slightly lower level, the upper pulmonary vein. The lower pulmonary vein lies in the lowest part of the root, below and slightly posterior to the main bronchus. If the specimen is well injected, branches of the right bronchial artery may be distinguished on the posterior faces of the air tubes; and anterior to and between the great blood-vessels, and between them and the bronchi, are a number of bronchial glands, which are easily distinguished by the black pigment deposited within them.

On the left side, in the posterior part of the root of the lung, the dissectors will see the cut section of the left bronchus, and, in many cases, a section of its first ventral branch also. The left pulmonary artery is above the bronchus, and its anterior wall is on a slightly anterior plane. The upper left pulmonary vein is anterior to the bronchus, and the lower left pulmonary vein is below the bronchus. In a well injected specimen the two left bronchial arteries may be seen on the posterior wall of the bronchus, and a number of bronchial glands will be found between and around the large blood-vessels and the bronchus.

Turning next to the mediastinal pleura *on the right side*, the dissectors will note, anterior to and below the root of the lung, a large bulging, due to the heart and pericardium, which lie in the middle mediastinal area. Continuous with the upper and lower ends of the posterior part of this bulging they will see two longitudinal elevations. The upper, from the level of the third costal cartilage to the lower margin of the first rib, is due to the superior vena cava, and above that level, to the right innominate vein. The lower elevation is very short, and is caused by the upper part of the inferior vena cava. A secondary ridge, formed by the phrenic nerve and the accompanying blood-vessels, descends along the elevation caused by the innominate vein and the superior vena cava, crosses anterior to the root of the lung, runs down along the posterior part of the bulging due to the heart, and the anterior border of the inferior caval elevation. Arching over the root of the lung is a curved ridge, due to the upper part of the vena azygos, as it passes forwards to join the superior cava. Above the vena azygos and posterior to the superior cava, the right surface of the trachea, or main air tube, may be seen or felt in the superior mediastinal region, and, descending obliquely across it, from above downwards and backwards, the right vagus nerve can be palpated or seen. Behind to the root of the lung and to the bulging due to the heart, the œsophagus may be recognised in the posterior mediastinal area, either by touch or sight, or both. Somewhat posterior to the œsophagus the margin of the ascending portion of the vena azygos may be noted, and still further back are the bodies of the vertebræ and the posterior parts of the ribs. Crossing the bodies of the vertebræ horizontally, the right intercostal vessels may be visible or they may be felt, and, descending along the line of the heads of the ribs, the sympathetic trunk and the roots of the greater splanchnic nerve can be recognised by touch, if not by sight.

Examine next the mediastinum and the posterior wall of the thorax on the left side (see Figs. 9, 12, and 14).

By inspection and palpation the positions of the larger and more important structures are easily recognisable. Below and anterior to the root of the lung the mediastinal pleura is bulged much more laterally on the left than on the right side by the heart covered by the pericardium. Arching backwards and to the left, above the root of the lung, in the superior mediastinal area, is the arch of the aorta, and from its posterior end the descending aorta runs downwards, in the posterior mediastinal area, first posterior to the root of the lung, and then posterior to the heart, but separated, in part, from the heart by the œsophagus, which diverges towards the left side in the lower part of the thorax. Above the arch of the aorta the left common carotid and subclavian arteries and the œsophagus can be distinguished, in the above order antero-posteriorly. A long, slender secondary ridge, produced by the left phrenic nerve and the accompanying vessels descends along the line of the common carotid artery, crosses the arch of the aorta, and then continues along the side of the pericardium. Above the aortic arch, and posterior to the ridge caused by the phrenic nerve, the left vagus nerve can be seen or felt, as it runs downwards along the anterior border of the left subclavian artery, and then downwards and backwards across the arch of the aorta, to disappear behind the root of the lung. Posterior to the descending aorta the sympathetic trunk of the left side can be seen or palpated as it descends along the line of the heads of the ribs.

Anterior to the pericardium and the aortic arch and its branches, the mediastinal pleura passes forwards to the back of the sternum, in contact with the pleura of the opposite side.

When the inspection and palpation of the structures

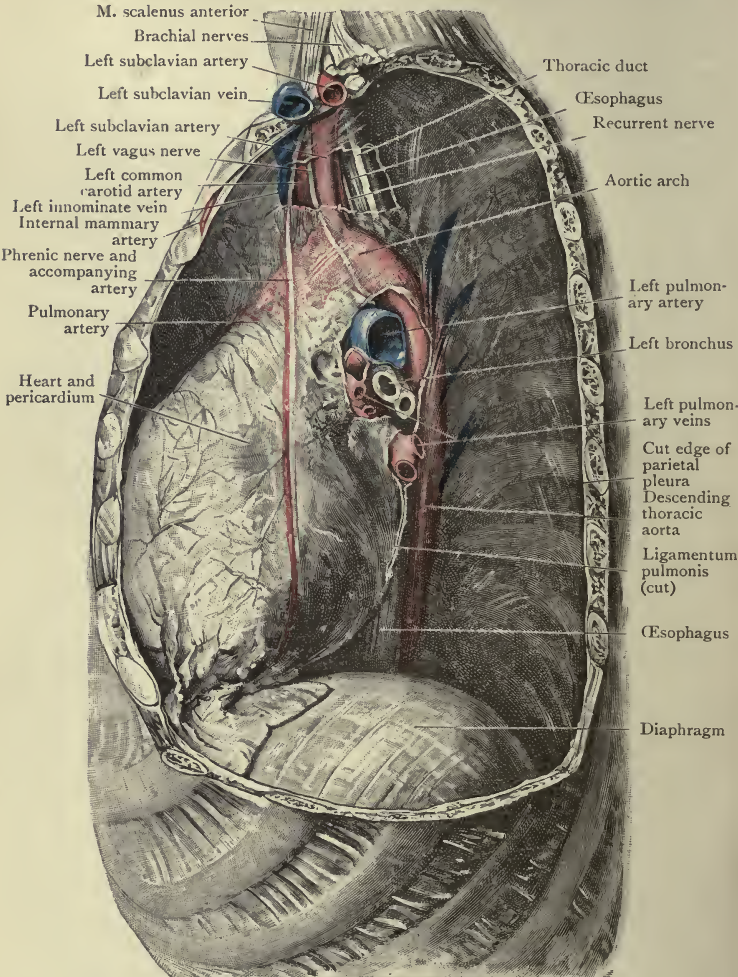


FIG. 12.—The Left Pleural Chamber opened up by the removal of its lateral wall. The lung has been taken away and a "window" has been made into the superior mediastinum by the removal of a portion of the mediastinal pleura. Several of the structures which form the mediastinal partition are seen shining through the mediastinal pleura which is *in situ*.

lying in relation with the mediastinal and posterior parts of the costal pleura are satisfactorily completed, the greater part of the pleura should be removed on both sides.

Dissection.—Make a longitudinal incision through the mediastinal pleura immediately anterior to the phrenic nerve, and a similar incision posterior to the nerve.

From the anterior longitudinal incision an incision should be carried forwards, at the level of the middle of the root of the lung, and from the posterior longitudinal incision another cut should be carried backwards to the front of the root of the lung and then along its anterior surface. Then the root of the lung should be turned forwards and an incision should be made on its posterior surface parallel with that already made on the anterior surface. This incision should be carried backwards from the root of the lung across the posterior part of the wall of the mediastinum, and then laterally, across the posterior wall of the thorax. When the incisions are completed four flaps will be marked out, two anterior and two posterior.

The upper anterior flap on the right side must be turned forwards to the level of the anterior border of the superior vena cava, where it may be cut away, the portion of the pleura extending from the superior vena cava to the sternum being left *in situ*. The upper anterior flap on the left side should be turned forwards to the anterior part of the arch of the aorta and the anterior surface of the upper part of the pericardium, where it should be cut away, the part extending further forwards to the sternum being left in position. The lower anterior flap on each side must also be turned forwards till the anterior part of the pericardium is reached. There it may be cut away, but the portion of pleura extending from the pericardium to the sternum should not be interfered with at present.

The posterior flaps on each side should be completely removed, care being taken to avoid injury to any of the structures which they cover.

After the pleural flaps have been removed the structures which are exposed must be cleaned.

On the right side commence with the vena azygos, as it arches over the root of the lung; follow it backwards and then, as far as possible, downwards, raising the right margin of the œsophagus where it overlaps the vein. Then clean the sympathetic trunk, which lies along the heads of the ribs, secure the two branches which pass backwards from each of its ganglia to the corresponding intercostal nerve and the branches which pass forwards from the lowest five of the eleven ganglia to form the greater and the lesser splanchnic nerves. Trace the splanchnic nerves as far downwards as possible. Attempt to find some of the branches which pass from the upper ganglia of the sympathetic trunk to the pulmonary plexus on the back of the root of the lung. Then clean the right aortic intercostal arteries and the intercostal veins as they cross the bodies of the vertebræ, and in the posterior parts of the intercostal spaces. The medial parts of the arteries cannot be traced at present. Clean also the branches of the superior intercostal artery which pass to the first two intercostal spaces. Note (1) that all the aortic intercostal arteries and all the intercostal veins except the first pass behind (external to) the sympathetic trunk (Fig. 13); (2) that the two intercostal branches from the superior intercostal artery do not pass behind the sympathetic trunk (Fig. 6); (3) that the intercostal vein from the first intercostal space passes upward to join the right innominate vein; (4) that the intercostal veins from the second, third, and sometimes that from the fourth also, join together to form a common trunk called the *right superior intercostal vein,* which terminates in the vena azygos; (5) that all the remaining intercostal veins on the right side end directly in the vena azgyos.

Next clean the right vagus. It descends along the right side of the trachea, passes medial to the arch of the vena azygos, and breaks up, on the back of the root of the lung, into the posterior pulmonary plexus. Look for fine branches which pass from its anterior border to the front of the root of the lung, where they join the anterior pulmonary plexus; then clean the posterior pulmonary plexus and trace the continuation of the vagus from it to the wall of the œsophagus, but do not follow it further at present. As the posterior pulmonary plexus is being cleaned look for the branches of the right bronchial artery which ramify on the posterior surfaces of the bronchi. Next clean the right side of the trachea from the vena azgyos to the upper aperture of the thorax and the right margin of the œsophagus, which lies posterior to the trachea. Follow the œsophagus as far as the back of the root of the lung, but do not injure the vena azygos. Finally, clean the pericardium and the superior and inferior venæ cavæ, behind and in front of the strip of pleura left covering the phrenic nerve (Fig. 13).

On the left side, after the pleural flaps have been removed, clean first the *left superior intercostal vein.* It runs from behind forwards, obliquely across the aortic arch, superficial (lateral) to the left vagus nerve. Follow it forwards only as far as the strip of pleura which was left in position covering the phrenic nerve. Then follow it backwards, and note that it is formed by the union of the intercostal veins of the first, second, and third intercostal spaces (Fig. 14), unless, as on the right side, the first intercostal vein passes to the innominate vein. Next clean the left sympathetic trunk. Secure the two branches which pass backwards from each of its ganglia to the corresponding intercostal nerve, and the branches which pass forwards from the lowest five of the eleven ganglia to form the greater and the lesser splanchnic nerves. Follow the splanchnic nerves as far as possible downwards. Attempt to find some of the branches which pass forwards from the upper ganglia to the left posterior pulmonary plexus. Then pull the descending aorta as far forwards as possible, and clean the left aortic intercostal arteries and the accompanying veins and the intercostal branches of the left superior intercostal artery. Note (1) that the upper two intercostal arteries are derived from the superior intercostal artery, and that they do not pass posterior to the sympathetic trunk; (2) that all the other intercostal arteries and veins pass posterior to (external to) the sympathetic trunk, except the left superior intercostal vein which is formed by the union of three or more intercostal veins after they have crossed the sympathetic trunk; (3) that the fourth, fifth, sixth, and seventh, and sometimes the eighth intercostal veins end in a common trunk called the accessory hemiazygos vein, which passes behind the aorta and the œsophagus to join the azygos vein ; (4) that the remaining intercostal veins end in a common trunk called the hemiazygos vein, which also passes behind the aorta and the œsophagus to join the azygos vein.

Next clean the left vagus nerve as it descends along the front of the left subclavian artery and across the arch of the aorta. Attempt to find the small branches which pass from it to the anterior pulmonary plexus on the front of the root of the lung, and springing from its medial side, at the level of the aortic arch, find its recurrent branch, which dips backwards below the arch. Then follow the vagus to the posterior pulmonary plexus on the back of the root of the left lung. Clean the plexus and follow the vagus from it to the œsophagus, but not further at present. Then clean the descending aorta. Now turn to the interval between the left vagus and the strip of pleura covering the left phrenic nerve, and dissecting carefully in the areolar tissue find two small nerves, the superior cervical cardiac branch of the left sympathetic trunk and the inferior cervical cardiac branch of the left vagus. The sympathetic cardiac branch is next the vagus and the vagus cardiac branch next the phrenic nerve. When the two small cardiac nerves have been found do not trace them, at present, below the lower border of the aortic arch, but turn to the left subclavian artery and clean it. Then clean carefully the area behind it and display the left border of the œsophagus, with the left recurrent nerve running along its anterior margin, and the thoracic duct ascending along its posterior margin (Fig. 14, in which the recurrent nerve is seen but is not labelled). Lastly, clean the pericardium in front of and behind the strip of pleura covering the left phrenic nerve.

Contents of the Mediastinum and the Structures of the Posterior Wall of the Thorax seen from the Right Side.—After the pleura has been removed from the right side of the thorax and the extra-pleural tissue has been dissected away, the following structures are exposed. Below and anterior to the root of the lung is the pericardium, covering the right atrium of the heart. Entering the pericardium below and posteriorly is the thoracic part of the inferior vena cava, and entering the upper part is the superior vena cava. The upper end of the superior vena cava is continuous with the right innominate vein, which lies posterior to the sternal end of the first costal cartilage. Arching over the root of the lung, to join the superior vena cava, is the terminal part of the azygos vein. Above the azygos vein and posterior to the superior vena cava are parts of the trachea, the right vagus nerve, and the œsophagus. On the posterior surface of the root of the lung is the posterior pulmonary plexus, formed by the vagus nerve; and posterior to the lung root is the vena azygos. At a lower level, posterior to the pericardium, the

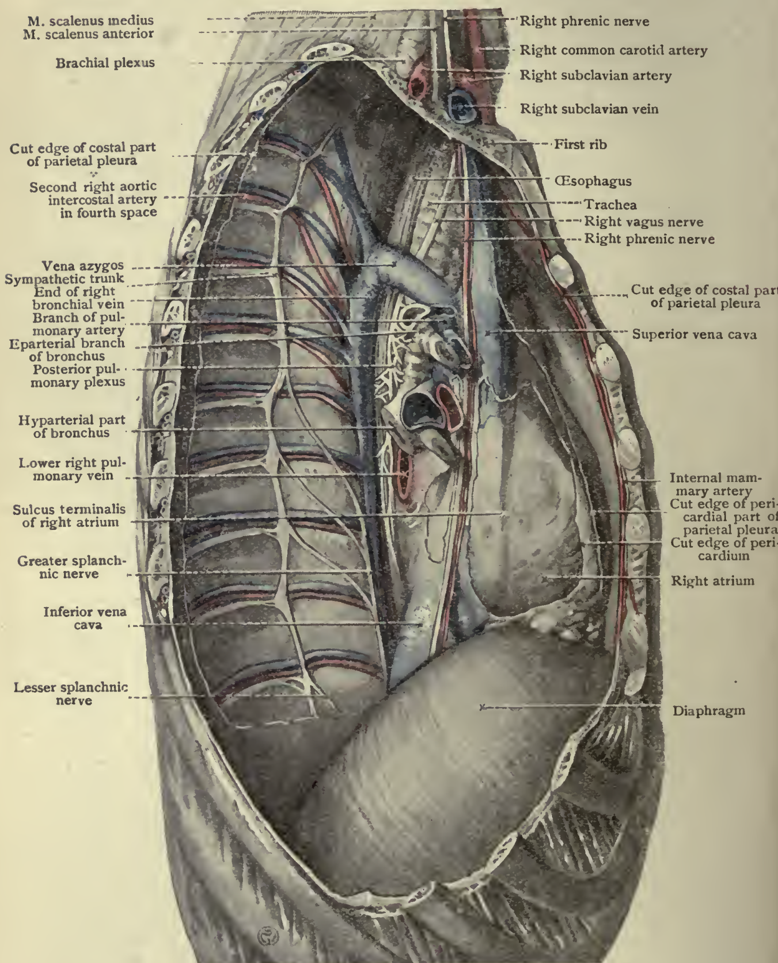


FIG. 13.—Dissection of Thorax from right side showing the constituent parts of the middle, superior and posterior mediastina.

right margin of the œsophagus will be found anterior to the vena azygos. Lateral to the vena azygos, on the sides of the bodies of the vertebræ, lie the right aortic intercostal arteries, the accompanying veins, and the splanchnic nerves. Still more laterally, on the line of the heads of the ribs, runs the sympathetic trunk, and beyond the sympathetic trunk are the intercostal spaces and their contents (Fig. 13).

The phrenic nerve still covered by the strip of pleura left *in situ* descends along the right innominate vein, the superior vena cava, the pericardium, and the inferior vena cava.

Contents of the Mediastinum and the Structures of the Posterior Wall of the Thorax seen from the Left Side.— After the removal of the four pleural flaps, described on p. 33, and the extra-pleural areolar tissue, the following structures are visible in the thorax on the left side (see Fig. 14). Below and anterior to the root of the lung is the pericardium, covering the left atrium, the left ventricle, the conus arteriosus of the right ventricle and the pulmonary artery. Above the root of the lung is the arch of the aorta. The arch of the aorta terminates posteriorly in the descending aorta, which passes downwards behind the root of the lung and the pericardium, but it is separated from the lower part of the posterior wall of the pericardium by the œsophagus, which, at that level, is inclining towards the left side. On the left and anterior aspect of the aortic arch, from behind forwards, lie the left vagus nerve, the superior cervical cardiac branch of the left sympathetic trunk, the inferior cervical cardiac branch of the left vagus, and the left phrenic nerve, with its accompanying vessels. Crossing the arch obliquely, from behind forwards and upwards, is the left superior intercostal vein, which passes lateral to the vagus and medial to the phrenic nerve. Above the arch of the aorta are the lower parts of the left common carotid and left subclavian arteries, and posterior to the latter lies the œsophagus, with the thoracic duct running along its left border on a posterior plane, and the left recurrent nerve ascending along its anterior margin.

Posterior to the descending aorta are the left aortic intercostal arteries, the accompanying veins, and the splanchnic nerves; and still more posteriorly and laterally lie the sympathetic trunk of the left side and the left intercostal spaces and their contents.

After the relative positions of the structures exposed by the removal of the mediastinal pleura have been examined on both sides, the dissectors should study the sympathetic trunks and their branches and communications.

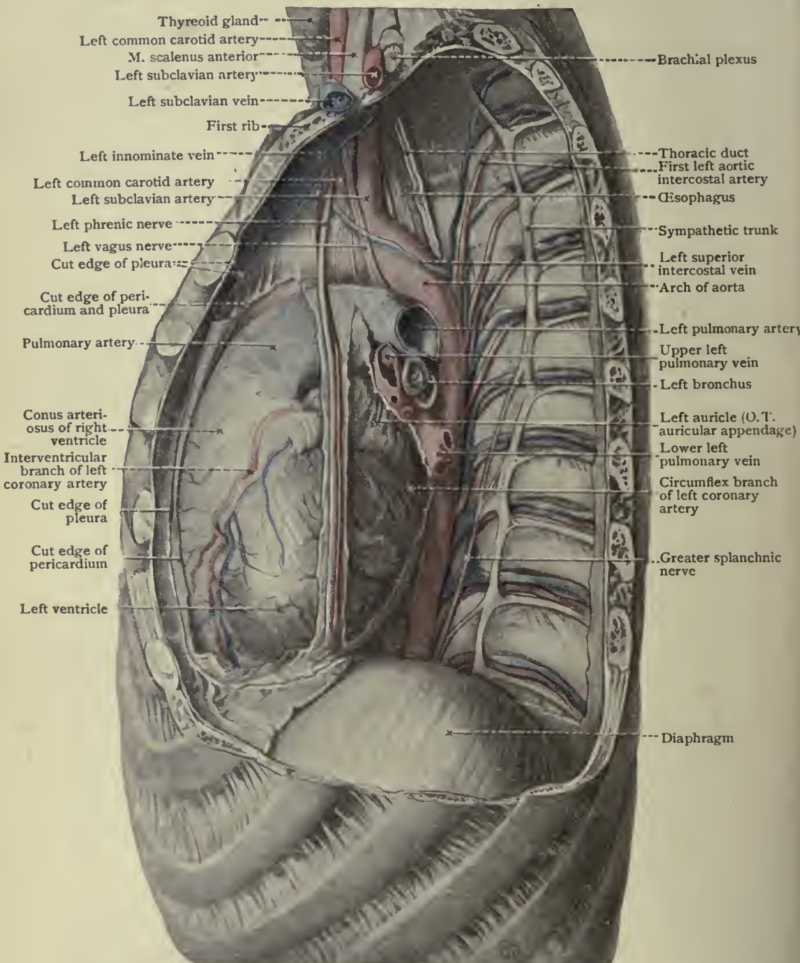


FIG. 14.—Dissection of Thorax from left side showing the constituent parts of the superior, middle and posterior mediastina.

The Truncus Sympathicus.—The thoracic portion of the sympathetic trunk on each side is continuous above with the cervical portion and below with the abdominal portion. It has the appearance of a knotted cord. The knots are ganglia, which consist of nerve cells and fibres. The intermediate parts of the trunk consist of nerve fibres alone. There are usually eleven ganglia, and, as a rule, each ganglion lies opposite the head of a rib, but the first is opposite the medial end of the first intercostal space, or anterior to the neck of the first rib; and, as the trunk inclines forwards below, one or two of the lower ganglia lie on the bodies of the lower thoracic vertebræ.

Branches.—The branches of each sympathetic trunk may be divided into two groups—(1) *Lateral*; (2) *Medial.*

(1) *Lateral Branches.*—From each ganglion two branches pass laterally into the adjacent intercostal space, where they join the corresponding intercostal nerve. One of the branches, called the white root of the ganglion, contains medullated fibres which are passing from the medulla spinalis (O.T. spinal cord) through the intercostal nerve to the ganglion. The other, the grey root, consists of non-medullated fibres which are passing from the cells of the ganglion to the intercostal nerve. Some of the fibres of the grey root are distributed with the branches of the intercostal nerve, and others run medially, in the intercostal nerve, to the spinal nerve trunk, whence some are distributed by the posterior ramus and others pass more medially to the membranes of the medulla spinalis.

(2) *Medial Branches.* — (*a*) Pulmonary; (*b*) Aortic; (*c*) Splanchnic. (*a*) The pulmonary branches arise from the second, third, and fourth ganglia. They run forwards to the posterior surface of the root of the lung, where they communicate with branches of the vagus, and assist in forming the posterior pulmonary plexus. (*b*) The aortic branches are fine filaments which arise from the upper five ganglia and pass to the coats of the aorta; the dissector will rarely be able to trace them in an ordinary dissection. (*c*) The splanchnic branches arise from the sixth to the last ganglion, and they run together to form three distinct nerves—the greater, the lesser, and the lowest splanchnic nerves, which are all destined for the abdominal viscera.

Nervus Splanchnicus Major.—The greater splanchnic nerve is formed by the union of four or five roots derived from the sixth to the tenth ganglia, or from the portions of the trunk between the ganglia. It passes downwards, on the bodies of the vertebræ, enters the abdomen by piercing the crus of the diaphragm, and ends in the cœliac ganglion of the same side.

Opposite the last thoracic vertebra there is frequently a small ganglion upon the greater splanchnic nerve, or connected with it; from that ganglion branches are distributed to the aorta, where they communicate with their fellows of the opposite side.

Nervus Splanchnicus Minor.—The lesser splanchnic nerve arises by two roots either from the ninth and tenth, or from the tenth and eleventh ganglia. It also pierces the crus of the diaphragm and ends in the cœliac ganglion.

Nervus Splanchnicus Imus.—The lowest splanchnic nerve is a minute branch which springs from the last thoracic ganglion. It is frequently absent, but when it is present it pierces the crus of the diaphragm and ends in the renal plexus.

Dissection.—When the study of the thoracic portion of the sympathetic trunk and its branches is completed, the posterior parts of the intercostal spaces should be cleaned and examined. The internal intercostal muscles will be seen passing as far medially as the angles of the ribs. In some cases fibres with the same direction as those of the internal intercostal muscles will be found descending from one rib to the second or third below, across the pleural surfaces of the intervening ribs. Such fibres constitute the *subcostal muscles*, which are very variably developed in different subjects. Sometimes they form an almost complete lining for the posterior part of the thoracic wall, and in other cases they are represented by a few scattered fibres, or they are entirely absent.

After the posterior parts of the intercostal spaces have been cleaned, remove, on both sides, the strip of pleura which was left over the phrenic nerve; then clean the nerve and the accompanying vessels, but do not displace the nerve. If the nerve is accidentally displaced fix it back in position by means of a few stitches, attaching the right nerve to the right innominate vein, the superior vena cava, the pericardium, and the inferior vena cava, along which it runs, and the left nerve to the left common carotid artery, the arch of the aorta, and the pericardium.

After the phrenic nerve has been cleaned the dissector on the left side should follow the recurrent branch of the vagus below the arch of the aorta, and at the lower border of the arch, immediately medial and anterior to the recurrent nerve, he should find a fibrous cord, called the *ligamentum arteriosum*, which connects the inferior border of the arch with the commencement of the left pulmonary artery. The ligament must be carefully cleaned and preserved, but the superficial cardiac plexus which lies medial to it must not be interfered with at present. When the dissection outlined above is completed the dissectors should study the vena azygos, the left superior intercostal vein, the phrenic nerves and their accompanying vessels, and the posterior intercostal membranes.

The Vena Azygos.—The azygos vein enters the thorax through the aortic aperture of the diaphragm, to the right of the aorta and thoracic duct, the lower parts of which will be displayed as the vein is cleaned. After entering the thorax

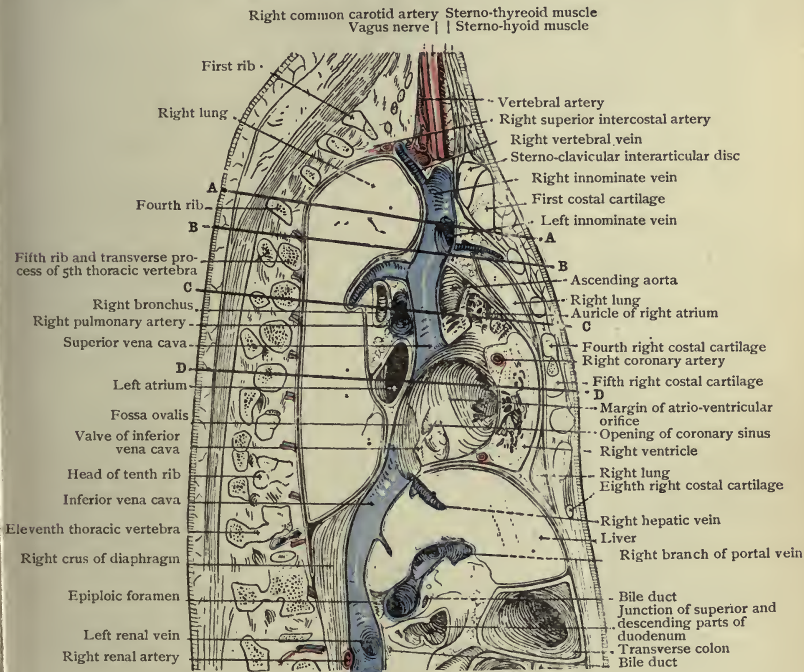


FIG. 15.—Sagittal section and partial dissection of the upper part of the trunk of a young Male Adult. The section is to the right of the median plane along the line of the superior and inferior venæ cavæ and it passes through the right margin of the left atrium of the heart. The atria were partially distended and the ventricles were contracted.

A-A.	Plane of section of		Fig.	22.
B-B.	,,	,,	,,	23.
C-C.	,,	,,	,,	20.
D-D.	,,	,,	,,	21.

the vein ascends along the right side of the aorta, from which it is separated by the thoracic duct. A short distance above the diaphragm it passes more or less completely behind the right border of the œsophagus. At the lower border of the root of the lung it emerges from behind the œsophagus, passes upwards behind to the root of the lung, turns forwards above its superior border, at the level of the fifth thoracic vertebra, and joins the superior vena cava, on its posterior aspect, immediately above the point where the latter enters the pericardium, at the level of the second costal cartilage (see Figs. 13, 15). As it turns forwards the vein lies immediately to the right side of the œsophagus, trachea and vagus nerve (Figs. 13, 31).

The tributaries of the vena azygos are: (1) The right superior intercostal vein, which drains blood from the greater part of the second and third intercostal spaces. (2) The lower eight intercostal veins and the subcostal vein of the right side. (3) The vena hemiazygos, and frequently (4) the vena hemiazygos accessoria. Both the latter enter it from the left. In many cases the accessory hemiazygos vein joins the hemiazygos vein. (5) Two or more bronchial veins from the right lung. (6) Some veins from the œsophagus. (7) Some minute pericardial veins.

The vena azygos commences in the abdomen, where it anastomoses either with the ascending lumbar veins (see p. 408) or directly with the inferior vena cava. Thus, it forms a more or less direct anastomosis between the two venæ cavæ.

The intercostal veins and the accompanying arteries and nerves, on both sides, and the hemiazygos and accessory hemiazygos veins will be studied at a later period of the dissection (see p. 140).

The Left Superior Intercostal Vein.—This vein is formed by the intercostal veins from the second and third intercostal spaces of the left side, and it not uncommonly receives communicating veins from the first and fourth spaces. It descends along the medial border of the first left aortic intercostal artery to the posterior end of the aortic arch; there it turns forwards, along the left side of the aortic arch, and, passing at the same time obliquely upwards, it crosses lateral to the left vagus and medial to the left phrenic nerve (Fig. 14). At a later period of the dissection it will be traced to its termination in the left innominate vein.

The Posterior Intercostal Membranes are medial to the internal intercostal muscles and on a more posterior plane. Each is attached, medially, to the anterior costo-transverse ligament, which passes from the neck of the rib below to the lower border of the transverse process of the vertebra above. Laterally, it is continuous with the fascial layer between the internal and external intercostal muscles, and above and below, it is attached to the adjacent ribs. On the pleural surface of the posterior intercostal membrane, in each space, lie the corresponding intercostal nerve and vessels (see Figs. 13 and 14); they pass laterally, on the internal surface of the membrane, and disappear posterior to the border of the internal intercostal muscle. When the membranes are removed the posterior fibres of the external intercostal muscles will be exposed. They extend, medially, as far as the tubercles of the ribs.

Nervi Phrenici.—Each phrenic nerve arises in the neck from the cervical plexus, receiving fibres from the third, fourth, and fifth cervical nerves. It descends on the scalenus anterior muscle and, on the right side, at the root of the neck, crosses the front of the subclavian artery and runs posterior to the innominate vein; but on the left side, as it leaves the scalenus anterior, it descends parallel with and in front of the subclavian artery and it passes behind the commencement of the innominate vein. As it enters the upper aperture of the thorax it crosses the internal mammary artery, passing from its lateral to its medial side; then it descends along the lateral border of the mediastinum, anterior to the root of the lung, to reach the diaphragm, where it breaks up into branches. The majority of the branches pass between the muscular fibres of the diaphragm and, after communicating with the abdominal sympathetic nerve fibres which form the diaphragmatic plexus, they are distributed to the muscle from its lower surface. The relations of the phrenic nerves in the thorax are different on the two sides.

The *right phrenic nerve* descends along the lateral borders of the right innominate vein and the superior vena cava to the point where the latter enters the pericardium; then along the side of the pericardium, which separates it from the sinus venarum of the right atrium (see Figs. 13, 20, 21, 22, 23).

In the upper part of the thorax the *left phrenic nerve* runs downwards between the left common carotid and the left subclavian arteries and, whilst lying between them, it crosses in front of the left vagus and behind to the left innominate vein. In the lower part of the superior mediastinum it passes lateral to the arch of the aorta and the left superior intercostal vein; then, descending into the middle mediastinum, it lies at first anterior to the root of the left lung, and afterwards it runs downwards along the side of the pericardium. The pericardium separates it from the auricle of the left atrium and from the left ventricle of the heart.

The left phrenic nerve is longer than its fellow of the right side, partly on account of the lower position of the diaphragm, and partly on account of the greater projection of the heart on the left side.

Branches of the Phrenic Nerves.—The main distribution of the phrenic nerves is to the diaphragm, but some minute sensory twigs are given off by each nerve to the pericardium and to the pleura. The student should note the great importance of the phrenic nerves. They are the nerves of supply to the diaphragm, which is the chief muscle of respiration.

Arteriæ Pericardiacophrenicæ.—The pericardiaco-phrenic artery, one on each side, is given off from the upper part of the internal mammary artery at the root of the neck. Each accompanies the corresponding phrenic nerve, through the superior and middle mediastina, to the diaphragm. It gives branches to the pleura and the pericardium, and it terminates in branches which anastomose, in and on the diaphragm, with the ramifications of the inferior phrenic and musculo-phrenic arteries. Each pericardiaco-phrenic artery is accompanied by venæ comites, which end in the internal mammary vein of the same side.

Dissection.—Before the lungs are examined the pericardium should be opened on each side in order that the dissectors may make themselves familiar with the relations of the heart to the mediastinal pleura, and to the mediastinal surface of the lungs.

Two longitudinal incisions must be made on each side, one anterior and one posterior to the phrenic nerve (see Figs. 13 and 14). On the right side the incisions should commence at the level of the upper pulmonary vein. On the left side the anterior incision should begin at the lower border of the aortic arch, and the posterior at the level of the left pulmonary artery (see Fig. 14). On both sides the longitudinal incisions must descend to the lower border of the pericardium. On both sides incisions should be carried forwards from the upper and lower ends of the anterior longitudinal incision to the line along which the mediastinal pleura was left attached to the anterior surface of the pericardium (see Figs. 13 and 14). From the upper end of the posterior longitudinal incision on the right side a cut should be made downwards and backwards, along the anterior aspect of the root of the lung, to the upper end of the inferior vena cava (see Fig. 13).

From the upper end of the posterior longitudinal incision on the left side an oblique cut must be made downwards and backwards, along the line of the anterior surface of the root of the left lung. When the incisions have been made, the anterior flaps can be turned forwards and the posterior flaps downwards. None of the flaps must be removed, for it will be necessary to replace them in position at a later stage of the dissection.

When the flaps marked out by these incisions are turned aside, the dissectors will find that, on the right side, they have exposed the greater part of the right atrium (see Fig. 13). They should note that the area of the atrium which is exposed is separated into two parts by a vertical sulcus, the *sulcus terminalis*, which runs from the anterior face of the cardiac end of the superior vena cava to the anterior aspect of the terminal part of the inferior vena cava. This sulcus divides the atrium into a posterior part, the *sinus venarum*, and an anterior part, the *atrium proper*. The upper and anterior part of the atrium is prolonged medially to the anterior surface of the heart. On the left side, the greater part of the heart exposed by the reflection of the pericardial flaps is the left ventricle, but in the upper part of the area the auricle (O.T. auricular appendage) of the left atrium is seen. Anterior to it lie the stem of the pulmonary artery and the upper part of the anterior portion of the right ventricle. A line of fat, in which lie the interventricular branch of the left coronary artery and the accompanying vein, indicates the position of the septum between the left and right ventricles (Fig. 14).

After the dissection is completed and the dissectors have carefully noted the relative positions of the various structures which have been exposed, they should proceed to study the lungs.

Pulmones.—The lungs are two comparatively light organs placed one on each side of the mediastinum. They are soft and spongy in texture, and if a small portion is pressed between the fingers and thumb a peculiar sensation called *crepitation* is felt, as the contained air is forced from one part to another. The ground colour of the surface of the adult lung of town-dwellers is slate-blue, but it is mottled with patches and fine lines of black, caused by deposited carbon particles. The lungs of children are of a yellowish-pink colour, similar to the colour of the lungs of healthy sheep.

The elasticity of the healthy lung substance is remarkable, but the student will not be able to demonstrate it in a lung hardened by formalin or injured by disease. He can, however, obtain from a butcher the fresh lungs of a sheep, and then, by inflating them through the trachea with the aid of a bellows, he will have no difficulty in satisfying himself of their elasticity. If, in the thorax under dissection, the lungs are healthy and not hardened, the dissectors found when they opened the pleuræ that the lungs shrank to about one-third of their original bulk (see p. 19). In such cases, with the consent of the dissectors of the head and neck, the dissectors have already distended the lungs and examined their elasticity (see p. 23).

The weight of an adult healthy right lung, containing an average amount of blood, is about 620 grm. (22 oz.), and

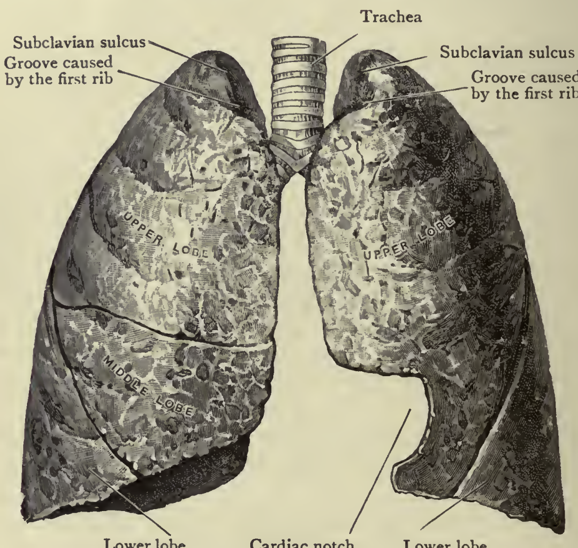


FIG. 16.—The Trachea, Bronchi, and Lungs of a Child, hardened by formalin injection.

that of the left is 570 grm. (20 oz.). The whole lung, or any healthy portion of it, will float in water.

A lung which will not float in water is either diseased or it has been taken from the body of an infant which has not breathed. Before the first respiration, which takes place after birth, the lungs are solid organs, and their bulk is small in proportion to their weight; therefore, when they are removed from the body and placed in water they sink.

The lungs, when healthy and sound, lie free within the cavity of the chest, and are attached only by their roots and by their pulmonary ligaments. It is rare, however, that a healthy lung is seen in the dissecting-room, for adhesions between the visceral and parietal portions of the pleura, due to pleurisy, are generally present. Each lung is accurately adapted to the space in which it lies, and, when hardened *in situ*, it bears, on its surface, impressions and elevations which are an exact counterpart of the inequalities of the structures with which its surfaces are in contact at the moment of fixation.

Each lung, in the natural condition, resembles half a cone; and it presents for examination an *apex*, a *base*, a *costal surface*, and a *medial surface*. An *anterior* and a *posterior border* separate the medial from the costal surface; and an *inferior*

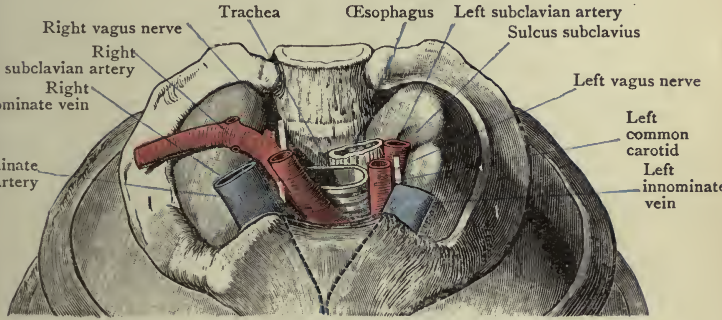


FIG. 17.—Cervical Domes of the Pleural Sacs, and parts in relation to them.

or *basal border* separates the base from the medial and costal surfaces. The apex rises into the root of the neck for one and a half inches above the level of the anterior part of the first rib, and it is crossed by the subclavian artery, which makes a groove upon the anterior border, a short distance below the summit, although the artery is separated from the lung by the membranous cervical diaphragm (Sibson's fascia), and by the pleura.

The base of each lung has a semilunar outline and is adapted to the upper surface of the diaphragm. Consequently it is deeply hollowed out, and, as the right cupola of the diaphragm ascends higher than the left, the basal concavity of the right lung is deeper than that of the left lung. The anterior, lateral, and posterior parts of the inferior margin of the lung are thin and sharp and extend downwards into the phrenico-costal sinus of the pleura, which intervenes between the diaphragm and the wall of the thorax. The lateral and posterior parts attain a somewhat lower position than the anterior part, but in all parts fall considerably short of the bottom of the sinus. The mediastinal part of the inferior margin, which lies along the lower border of the pericardium, is more rounded.

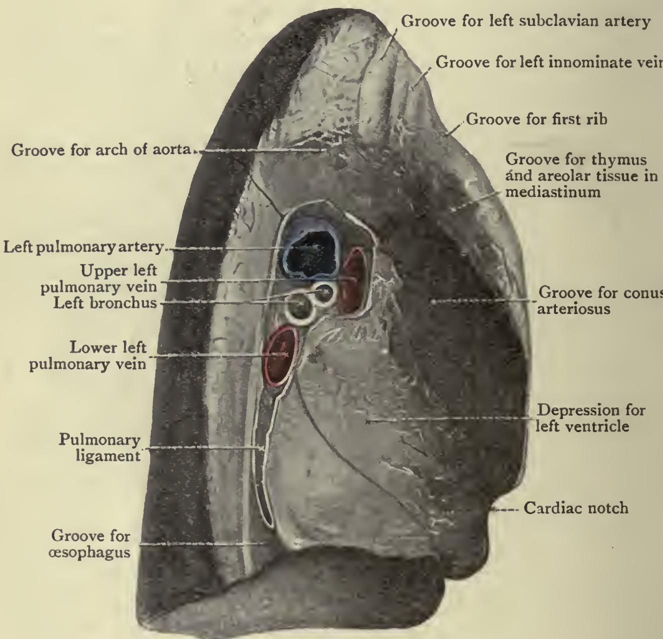


FIG. 18.—The Medial Surface of a Left Lung hardened *in situ.*

The diaphragm separates the base of the right lung from the upper surface of the right lobe of the liver, and the base of the left lung from the left lobe of the liver, the stomach, the spleen, and, in some cases, from the left extremity of the transverse colon.

The *costal surface* of the lung is very extensive and convex. It lies in relation with the costal pleura, which separates it from the ribs and intercostal muscles, the transversus thoracis and the sternum, and it bears the impressions of the costal arches.

The medial surface is separable into an anterior or *mediastinal portion* and a posterior or *vertebral portion.* The vertebral portion lies against the sides of the bodies of the vertebræ (Figs. 5, 20, 21, 22). The mediastinal part is

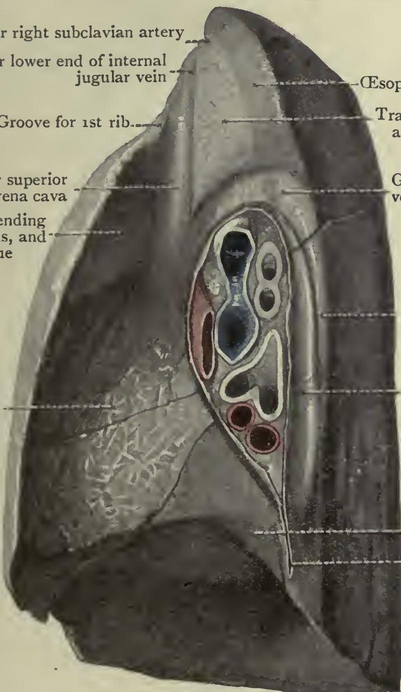


FIG. 19.—The Medial Surface of a Right Lung hardened *in situ.*

applied against the mediastinal partition and presents markings which are the exact counterparts of the inequalities of the corresponding surface of the mediastinum. Thus, it is deeply hollowed out in adaptation to the pericardium, upon which it fits (Figs. 5, 21). The pericardial concavity occupies the greater part of the mediastinal surface, and, owing to the greater projection of the heart to the left side, it is much more extensive in the left lung than in the right lung.

At the upper and posterior part of the pericardial area is the hilum of the lung. This is a wedge-shaped, depressed area through which the bronchus and the pulmonary artery, nerves, veins, and lymph vessels enter or leave the lung. It is surrounded by the pleura which is reflected from its margin on to the root of the lung, and the layer of reflected pleura round

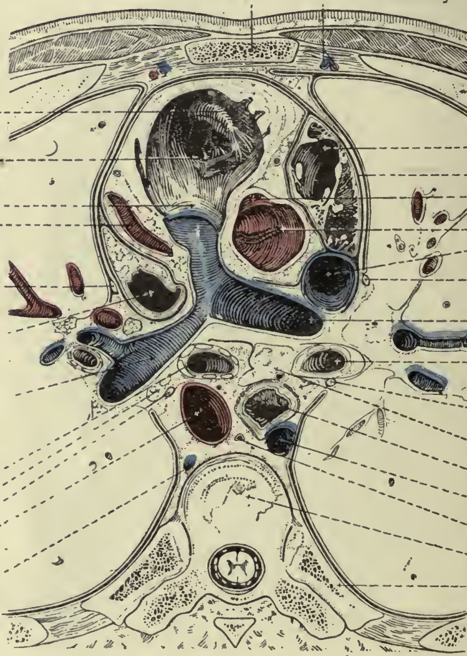


FIG. 20.—Transverse section through the Thorax of a young Male Adult along the plane **C-C**, Fig. 15.

the hilum is continuous, below, with the pulmonary ligament (Figs. 18, 19).

The portion of the pericardial area anterior to the upper part of the hilum of the left lung corresponds with the position of the conus arteriosus and the stem of the pulmonary artery (Fig. 18); and the same portion of the pericardial area on the right side corresponds with the position of the lower part of the superior vena cava posteriorly, and with

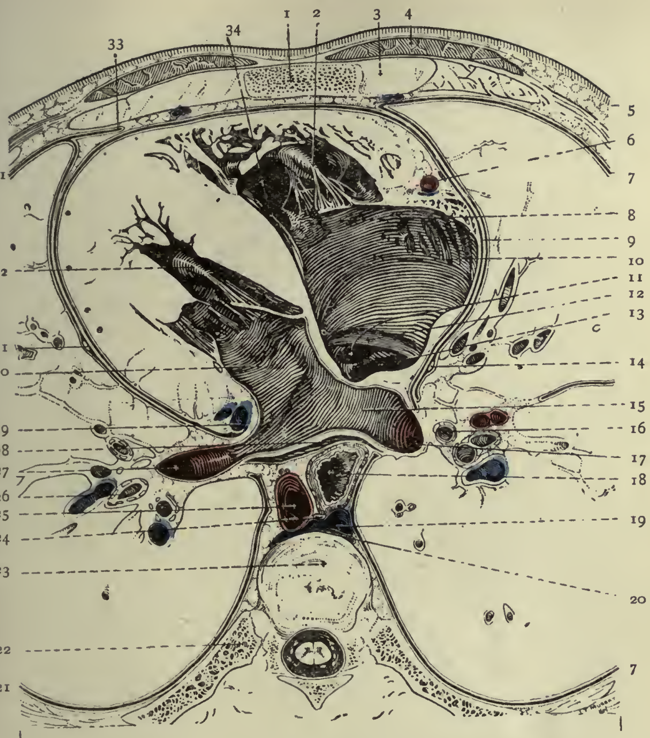


FIG. 21.—Transverse section through the Thorax of a young Male Adult along the plane **D-D**, Fig. 15.

1. Sternum.
2. Papillary muscle of right ventricle.
3. Fifth costal cartilage.
4. Pectoralis major.
5. Skin.
6. Right coronary artery.
7. Cavity of right pleura.
8. Musculi pectinati.
9. Pericardium.
10. Cavity of right atrium.
11. Opening of hepatic vein.
12. Valve of inferior vena cava.
13. Inferior vena cava.
14. Right phrenic nerve.
15. Left atrium.
16. Right bronchus.
17. Lower right pulmonary vein.
18. Œsophagus.
19. Vena azygos.
20. Accessory hemiazygos vein.
21. Cavity of left pleura.
22. Eighth rib.
23. Intervertebral cartilage between seventh and eighth thoracic vertebræ.
24. Thoracic duct.
25. Descending aorta.
26. Left bronchus.
27. Lower left pulmonary vein.
28. Oblique sinus of pericardium.
29. Coronary sinus.
30. Left atrio-ventricular orifice.
31. Left phrenic nerve.
32. Inferior papillary muscle of left ventricle.
33. Anterior margin of left pleura.
34. Septal cusp of tricuspid valve.

the ascending aorta anteriorly (Figs. 19, 20, 56). Below and behind the lower and posterior part of the pericardial area on the right lung is a secondary depression due to the upper part of the inferior vena cava. Posterior to the pericardial area and the hilum there is a narrow strip of the

FIG. 22.—Transverse section of the Thorax of a young Male Adult along the plane **A-A**, Fig. 15.
The œsophagus was distended but empty.

mediastinal surface of the lung which is in relation with the lateral wall of the posterior mediastinum. On the right lung this portion of the surface presents a longitudinal depression which corresponds with the right border of the œsophagus, and more posteriorly, at the upper part, there may be a groove caused by the vena azygos (Fig. 18). The left lung, in the corresponding situation, is marked by a deep longitudinal groove which is produced by the contact of the lung with the descending thoracic aorta; and, close to the base, a small triangular area, anterior to the aortic groove, lies in relation with the left border of the lowest part of the thoracic portion of the œsophagus (Fig. 19).

The portion of the mediastinal surface which lies above the hilum and pericardial hollow is applied to the lateral aspect of the superior mediastinum and the markings upon it are different on the two sides. On the left side, a broad deep groove, caused by the aortic arch, curves over the hilum and becomes continuous posteriorly with the aortic groove on the posterior mediastinal area (Figs. 18, 20, 21). From this arched groove a sharply cut sulcus, caused by the left subclavian artery, ascends on the medial side of the apex (Figs. 18, 22), and, turning laterally above, it crosses the anterior border of the apex a short distance below the summit. Immediately anterior to the subclavian sulcus the medial surface of the apex is occasionally marked by a shallow sulcus caused by the left innominate vein, and more inferiorly its anterior margin is depressed by the first rib. That portion of the surface which lies posterior to the subclavian sulcus is separated by areolar tissue from the œsophagus and thoracic duct.

On the right lung also a curved sulcus arches over the hilum. It is caused by the vena azygos, as it passes forwards to join the superior vena cava. The groove for the vena azygos is much narrower than the sulcus on the left lung due to the aortic arch. From the anterior end of the sulcus for the azygos vein a broad shallow sulcus passes upwards to the lower and anterior part of the apex; it is produced by the superior vena cava and the right innominate vein (Figs. 19, 20, 22), and in some cases it is prolonged to the upper part of the apex by a slight longitudinal depression due to the pressure of the internal jugular vein. Arching laterally, across the upper part of the anterior aspect of the apex, there is a shallow groove produced by the right subclavian artery. Posterior to the sulcus for the innominate vein, the medial surface of the apex lies in relation with the right side of the trachea and the vagus, and still further posteriorly it is either in relation with the right border of the superior mediastinal part of the œsophagus, or it is separated from it by a quantity of areolar tissue (Figs. 20, 22, 23).

The anterior and posterior borders of the lung are in marked contrast with each other. The anterior is comparatively short and thin, and it extends medially into the costo-

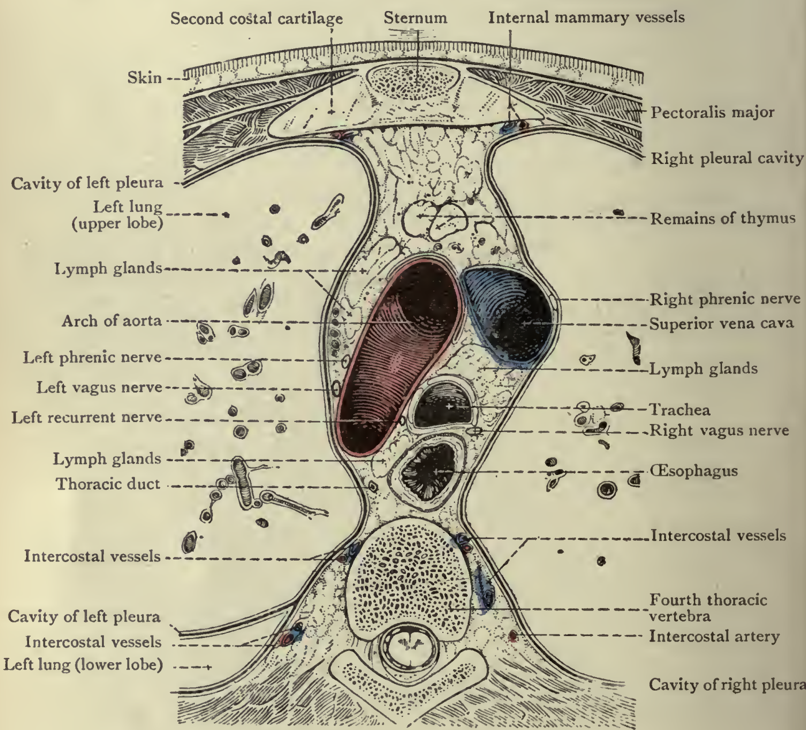


FIG. 23.—Transverse section of the Thorax of a Male Adult along the plane **B-B**, Fig. 15.

mediastinal sinus of the pleura, which lies posterior to the sternum and the costal cartilages. It commences at the apex, curves downwards, forwards and medially, posterior to the sterno-clavicular articulation, to the lower border of the manubrium sterni, and then it descends to the base. Immediately below the highest point of the apex it is grooved by the subclavian artery on each side, and on the left side it presents a *cardiac notch* at the level of the fifth costal cartilage. The posterior border is rounded and indistinct. It descends from the apex to the base, along the line of the articulations of the heads of the ribs with the bodies of the vertebræ, and it is considerably longer and thicker than the anterior border.

Lobes of the Lungs.—The *left lung* is divided into two lobes by a long, deep *oblique fissure* which penetrates its substance to within a short distance of the hilum. The oblique fissure begins above at the posterior border, about 62 mm. (two and a half inches) below the apex, at the level of the vertebral end of the fourth rib, which corresponds with the medial end of the spine of the scapula and the spine of the third thoracic vertebra. It is continued on the lateral surface, in a somewhat spiral direction, downwards and forwards till it cuts the inferior margin opposite the lateral part of the sixth costal cartilage. The *upper lobe* of the lung lies above and anterior to the oblique fissure. It is conical in form, with an oblique base. The apex and the whole of the anterior border belong to it. The *lower lobe*, somewhat quadrangular, is more bulky than the upper, and lies below and posterior to the fissure; it comprises the entire base and the greater part of the thick posterior border.

In the *right lung* there are two fissures subdividing it into three lobes. The *oblique fissure* is very similar in its position and relations to the fissure in the left lung, but it is more vertical in direction. It separates the lower lobe from the upper and middle lobes. The second cleft, the *horizontal fissure*, begins at the anterior border of the lung at the level of the fourth costal cartilage and extends horizontally till it joins the oblique fissure. The middle lobe, thus cut off, is wedge-shaped in outline. It lies between the oblique and horizontal fissures.

Differences between the two Lungs.—The dissectors should particularly note the following differences between the two lungs:—(1) The right lung is slightly larger than the left, in the proportion of 11 to 10. (2) The right lung is shorter and wider than the left lung. This difference is due to the great bulk of the right lobe of the liver, which elevates the right cupola of the diaphragm to a higher level than the left cupola, and also to the heart and pericardium, which project more to the left than to the right, and thus diminish the width of the left lung. (3) The anterior sharp margin of the right lung is more or less straight; the corresponding margin of the left lung presents, in its lower part, a marked angular deficiency (*incisura cardiaca*) for the reception of the heart and the pericardium. (4) The right lung is subdivided into three lobes, and the left lung into two.

Dissection.—The cardiac branches of the vagus and the sympathetic trunk which lie on the left surface of the arch of the aorta have already been found (p. 35). Trace them now, from the arch downwards into its concavity, to the right of the ligamentum arteriosum, where they terminate in the superficial cardiac plexus. Clean the superficial cardiac plexus, as far as possible, and trace twigs from it (1) upwards and backwards below the arch of the aorta towards the deep cardiac plexus, (2) downwards to the pulmonary artery and the heart, (3) laterally to the anterior pulmonary plexus of the left side.

The vagi nerves and branches from the thoracic sympathetic ganglia have already been followed to the posterior pulmonary plexuses on each side (p. 33). Now follow some of the branches of the plexus to the walls of the bronchus. Trace towards the œsoph agus other branches which connect the posterior pulmonary plexuses of opposite sides together. They pass both in front of and behind the œsophagus, and are of relatively large size.

When the posterior pulmonary plexuses and their connections have been examined, complete the cleaning of the bronchial arteries which run along the posterior faces of the bronchial tubes; then proceed to a detailed study of the roots of the lungs, using for the purpose the portions of the roots which are still attached to the mediastinum.

Radix Pulmonis.—The root of each lung is formed by a number of structures which enter or leave the lung at the hilum on its mediastinal surface. The main structures are: (1) the bronchial tube, through which air passes to and from the lung; (2) a pulmonary artery which carries venous or de-oxygenated blood from the right side of the heart to the lung to be oxygenated; (3) two pulmonary veins, upper and lower, which convey oxygenated blood from the lungs to the left side of the heart; (4) lymph vessels and lymph glands through which lymph passes on its way from the lung towards the right lymph duct on the right side and the thoracic duct on the left side; (5) one bronchial artery on the right side, and two on the left side, which carry oxygenated blood from the aorta to the walls of the bronchial tubes; (6) the anterior and posterior pulmonary plexuses of nerves and their branches.

The structures which compose the root of the lung are enclosed in a layer of visceral pleura, which has been removed, and are also bound together by areolar tissue, which is often dense and fibrous in the adult, especially around the lymph glands.

The bronchus is always easily identified by the firm elastic plates of cartilage which help to form its walls, as well as by its posterior position. The pulmonary artery can be distinguished, not only by its intermediate position between the bronchus and the veins, but also, as contrasted with the veins, by the greater relative thickness of its walls. The lymph glands are easily recognisable in the adult by

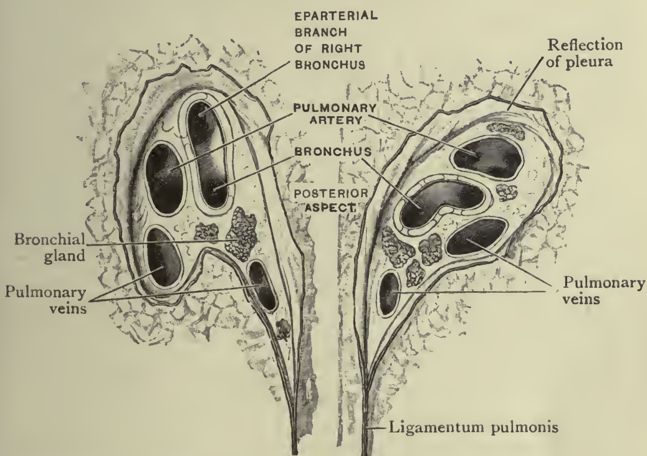


FIG. 24.—The two Pulmonary Roots transversely divided close to the hilum of each lung.

their black or greyish black colour, but in the young child they are yellowish pink in colour and are not so obvious. The bronchial arteries lie on the posterior faces of the bronchi, if they are not well injected they are difficult to trace, and the veins which accompany them are still more difficult to secure.

In both sides one bronchus and one pulmonary artery enter the root of the lung, and two pulmonary veins leave it. As the bronchus and artery enter the root the artery passes in front of the bronchus, and after they enter the hilum of the lung the artery descends behind the bronchus on its lateral side. The pulmonary veins lie at a lower level than the bronchus and artery, and the upper pulmonary vein is placed in a more anterior plane than either the artery or the bronchus. Before the right bronchus enters the hilum of the lung it gives off a large branch, called the *eparterial branch* because it arises above the level at which the pulmonary artery crosses the front of the main bronchus. There is no corresponding branch from the left bronchus. On both sides the branches given off below the point where the pulmonary artery crosses the main stem bronchus are called *hyparterial branches.* It necessarily follows from what has already been stated that in sections made through the root of the lung, at right angles to its long axis, the relative positions of the structures will vary slightly according to whether the section is nearer to or farther from the median plane; but in all such sections the upper pulmonary vein will lie in an anterior plane, the pulmonary artery in an intermediate plane, and the bronchus in a posterior plane. If the section is made close to the hilum of the lung, the relationship from before backwards, *on both sides*, is upper pulmonary vein, pulmonary artery, stem bronchus. The relationship from above downwards, *on the right side*, is eparterial bronchus, pulmonary artery, stem bronchus, pulmonary vein; and, *on the left side*, pulmonary artery, stem bronchus, pulmonary vein; the difference being due to the eparterial branch from the stem bronchus which is present only on the right side.

The Relations of the Roots of the Lungs.—Anterior to the root of each lung are the phrenic nerve, with its accompanying vessels, and the anterior pulmonary plexus; behind it, the posterior pulmonary plexus; and below it, the ligamentum pulmonis. In addition, in front of the root of the right lung is the superior vena cava; and above and behind it, the vena azygos; whilst above the root of the left lung is the aortic arch, and behind it, the descending aorta (Figs. 18 and 19).

It will be obvious to the dissector who has followed the preceding descriptions that parts of the main stems of the bronchi, the pulmonary arteries, and the pulmonary veins lie medial to the lungs and outside of their substance. They are the *extra-pulmonary parts.* They are only partially displayed at present, and the study of their special relations must be deferred until a later period (see p. 126). The portions of the bronchi and the pulmonary blood vessels which lie in the substance of the lungs are the intra-pulmonary parts, and an attempt should now be made to display their main relations.

Dissection.—Place the lung with its mediastinal surface uppermost; then follow the pulmonary veins into its substance. They lie in front of the main parts of the bronchi. *On the right side* commence with the upper pulmonary vein. At the hilum it will be found to receive two tributaries, one emerging from the upper lobe, and accompanying the eparterial bronchus, and the other issuing from the middle lobe, accompanying what will afterwards be found to be the first ventral hyparterial branch of the bronchus. It also receives a tributary from the medial part of the lower lobe. As the vein and its tributaries are cleaned, clean also the anterior aspects of the bronchi. Next, follow the inferior pulmonary vein; it accompanies the stem bronchus, below the level of its first ventral hyparterial branch, and it receives tributaries which correspond to all the hyparterial branches of the bronchus, except the first ventral branch and a small branch called the *first ventral accessory bronchus* which is given off from the front of the stem bronchus immediately below the first ventral hyparterial branch. After the veins have been cleaned follow the eparterial bronchus for a short distance into the substance of the upper lobe and note that it is the only bronchus distributed to that lobe. Next clean the hyparterial bronchus and attempt to display its two main sets of branches, *ventral* and *dorsal.* They will be recognised in the adult by their black or greyish-black colour. As the bronchi are being cleaned small pulmonary lymph glands will be met with in the angles between their branches. The ventral branches spring from the lateral border of the stem bronchus and run towards the anterior margin of the lung. The first ventral branch is the only branch distributed to the middle lobe (Fig. 25). The remaining three or four ventral branches and all the dorsal branches pass to the lower lobe.

The dorsal branches arise from the back of the hyparterial part of the stem bronchus and pass towards the thick posterior border of the lung. Clean them from their medial sides. Note that the ventral and dorsal branches arise alternately—first a ventral, then a dorsal. As the dissection proceeds the dissector will find some small hyparterial branches which lie intermediate between the ventral and dorsal branches; they are called *accessory bronchi.* Only one of the group of accessory bronchi is of special interest. It springs from the front of the stem bronchus immediately below the first ventral branch; it is, therefore, the second branch from the hyparterial part of the stem bronchus, and is the first ventral accessory bronchus (Fig. 25). It is of special interest because it is distributed to a portion of lung substance which occasionally becomes a separate lobe called *the infracardiac lobe*, the right lung then possessing four lobes. The artery which accompanies the first ventral accessory bronchus is frequently a branch of the artery to the middle lobe, and the vein terminates in the vein from the middle lobe.

After the bronchi have been cleaned follow the intra-pulmonary part of the pulmonary artery, as it descends along the postero-lateral aspect of the stem bronchus, between the ventral and dorsal hyparterial branches, and note that its branches correspond with the branches of the bronchus and run chiefly along their posterior aspects.

On the left side follow, first, the upper pulmonary vein, and note that its tributaries are derived only from the upper lobe of the left lung. Then follow the lower vein, which receives blood from the lower lobe. After the veins are displayed clean the hyparterial part of the stem bronchus and its ventral and dorsal branches, cleaning the dorsal branches from their medial sides. Note that the first ventral branch is relatively very large and that it is distributed entirely to the upper lobe, whilst all the other branches, ventral and dorsal, are distributed to the lower lobe. Finally, follow the pulmonary artery along the postero-lateral face of the stem bronchus, and note that it gives off branches which correspond, in number and position, with the branches of the bronchus and that they run along the posterior aspects of the bronchi which they accompany (Fig. 25).

Bronchi.—There are two primary bronchi, one for each lung. They spring from the termination of the trachea and each passes downwards and laterally to the hilum of the lung to which it belongs; then, having entered the lung through the hilum, it descends, in the substance of the lung, to the base. The dissector who has followed the preceding instructions will have noted that as the main bronchial stem traverses the lung substance it lies nearer the medial than the lateral surface of the lung and nearer the posterior than the anterior border. And he should also have noted that the apex of the lung is supplied by branches which ascend to it, whilst the other parts are supplied by branches of the bronchus which run mainly forwards or backwards, many of the branches having an inclination downwards.

The relations of the extra-pulmonary portions of the bronchi, which lie between the trachea and the lungs, cannot be completely studied at present. The intra-pulmonary relations are simple. *On the right side* the eparterial branch enters the upper lobe of the right lung accompanied by a branch of the superior right pulmonary vein and a branch of the right pulmonary artery. It breaks up in the substance of the upper lobe into numerous ramifications, all of which are accompanied by a corresponding pulmonary vein and artery. Below the eparterial branch the stem bronchus descends into the lower lobe, and as it descends it gives off a series of ventral and dorsal branches which arise alternately. Each branch is accompanied by a tributary of the pulmonary vein and a branch of the pulmonary artery. The first ventral branch is distributed to the middle lobe. It is accompanied by a tributary of the superior pulmonary vein. All the other hyparterial branches are distributed to the lower lobe, and are accompanied by tributaries of the inferior pulmonary vein and branches of the pulmonary artery (Fig. 25).

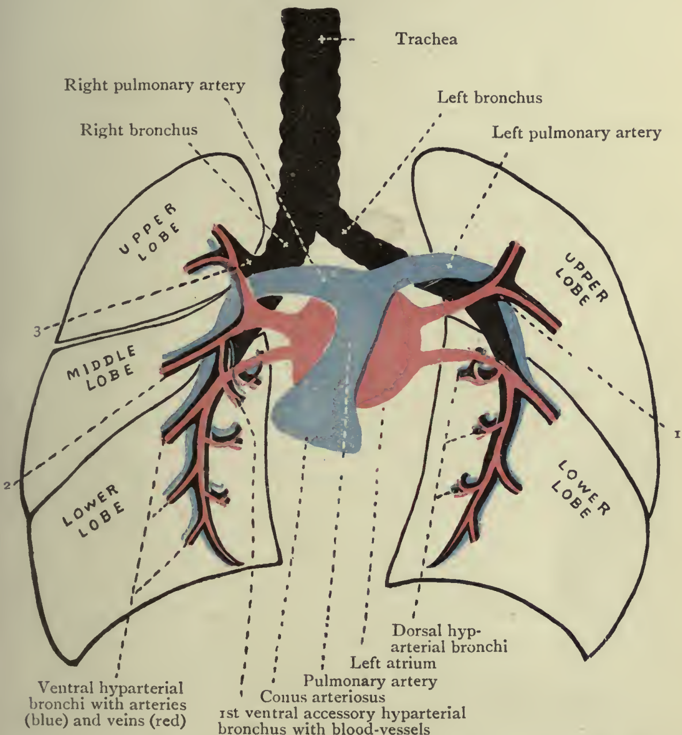


FIG. 25.—Diagram of the Lungs with the Bronchi and Blood-Vessels.

1. First left ventral hyparterial bronchus.
2. First right ventral hyparterial bronchus.
3. Eparterial bronchus.

All the bronchi, except the smallest terminal branches, are kept permanently open by bars and plates of cartilage, which lie in their walls and enable the bronchi to be so easily distinguished from the blood-vessels. Nevertheless the lumina of all the bronchi can be reduced in size by the contraction of the unstriped muscle fibres in their walls, for none of the bars or plates of cartilage extend completely round the walls of the tubes.

In the left lung the arrangement of the bronchi differs from the arrangement in the right lung because in the left lung there is no eparterial branch. The first ventral hyparterial branch is distributed to the upper lobe, and is accompanied by a branch of the left pulmonary artery and by the upper left pulmonary vein. All the remaining branches are distributed to the lower lobe, and are accompanied by corresponding branches of the pulmonary artery and by tributaries of the lower left pulmonary vein.

Arteriæ Bronchiales.—As a rule, two bronchial arteries are distributed to the left lung and one to the right lung. The two left bronchial arteries spring from the descending aorta. The right bronchial artery is a branch either of the first right aortic intercostal artery or of the upper left bronchial artery. The bronchial arteries and their branches run along the posterior surfaces of the bronchi and their branches, and are the proper nutrient vessels of the lungs. Part of the blood which they convey to the lungs is returned by the pulmonary veins to the left atrium of the heart, but the remainder is returned by bronchial veins, which open on the right side into the vena azygos, and on the left side into the vena hemiazygos accessoria, or into the left superior intercostal vein.

Arteriæ Pulmonales.—One pulmonary artery is distributed to each lung. As it passes through the root of the lung it crosses anterior to the stem bronchus, and it descends in the interior of the lung, postero-lateral to the stem bronchus, and between its ventral and dorsal hyparterial branches. It gives off branches which correspond with and are distributed with the branches of the bronchus. When the bronchi terminate in the alveolar passages the final ramifications of the arteries terminate in capillaries which form a vascular network between the walls of the alveoli. The pulmonary arteries carry venous (de-oxygenated and carbonic acid laden) blood from the right ventricle of the heart to the lungs, where, as the blood runs through the capillaries between the walls of the alveoli, it gives off its excess of carbonic acid to and receives oxygen from the air in the alveoli.

Venæ Pulmonales.—As a rule there are four pulmonary veins — upper and lower, on each side. Variations are, however, not uncommon, and the number may be increased to five, three on the right—one from each lobe of the right lung—and two on the left. On the contrary the number may be reduced to two—one on each side.

The pulmonary veins commence in the capillary plexuses between the walls of the alveoli; they accompany the bronchi, lying, as a rule, along their anterior faces, and they gradually unite together until on each side a terminal venous stem is formed in each lobe. The stems from the upper and middle lobes on the right side fuse together to form the upper right pulmonary vein. On the left side the stem from the upper of the two lobes forms the upper left pulmonary vein. On both sides the stem from the lower lobe is the lower left pulmonary vein.

The pulmonary veins carry arterial (oxygenated) blood from the lungs to the left atrium of the heart, whence it passes to the left ventricle and is then distributed to all the tissues of the body.

Vasa Lymphatica Pulmonum et Lymphoglandulæ Pulmonales et Bronchiales.—The lymph vessels of the lungs cannot be displayed in an ordinary "part," but the bronchial lymph glands, on account of their blackness and the dense fibrous tissue which binds them to the adjacent bronchi and blood-vessels, are disagreeably obvious, for they considerably increase the difficulties of the dissector who is attempting to clean the constituent parts of the root of the lung and the bronchi.

The lymph vessels of the lung convey lymph from the substance of the lung to the pulmonary lymph glands, which lie in the substance of the lung in the angles between the branches of the bronchial tubes. Having passed through the pulmonary lymph glands the lymph is carried onwards, by their efferent vessels, to the *broncho-pulmonary lymph glands*, which lie in the hilum of the corresponding lung in the angles between the stem and the highest branches of the bronchus. The broncho-pulmonary lymph glands also receive lymph directly from the visceral pleura. From the broncho-pulmonary lymph glands the lymph passes to the *tracheo-bronchial lymph glands*, which lie in the angle between the bronchus and the trachea on the lateral side; and to the *inter-tracheo-bronchial lymph glands*, which are placed in the angle between the two bronchi below the trachea. The latter glands receive lymph from both lungs. The tracheo-bronchial glands are connected with both the anterior and posterior mediastinal glands by inter-communicating lymph vessels. From the right tracheo-bronchial glands the greater part of the lymph passes through the broncho-mediastinal trunk to the right lymph duct, and so to the right innominate vein, but some is carried to the right inferior deep cervical glands, which lie at the root of the neck behind the sterno-mastoid muscle. The lymph from the left tracheo-bronchial glands flows to the thoracic duct and the left inferior deep cervical glands. The lymph from the inter-tracheo-bronchial glands

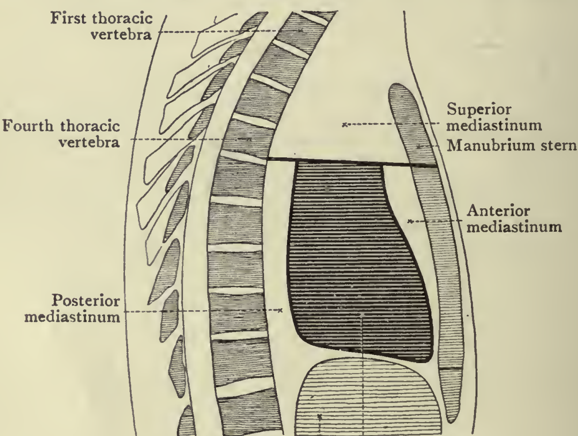


FIG. 26.—Diagram of the Mediastina.

flows partly to the broncho-mediastinal trunk and partly to the thoracic ducts.

The pulmonary, the broncho-pulmonary, and some of the tracheo-bronchial lymph glands were seen as the root of the lung and the bronchi were dissected. The remaining tracheo-bronchial and the inter-tracheo-bronchial lymph glands cannot be displayed until after the heart has been dissected (see p. 136).

The Mediastinum and its Contents.—It has been pointed out already that the mediastinum is the region which extends from the sternum to the vertebral column between the two pleural sacs; that it is occupied by some of the most important viscera, vessels and nerves in the body, *i.e.*, the heart, enclosed in the pericardium; the aorta and its great branches; the great vessels which carry the blood to and from the heart; the œsophagus and trachea; the

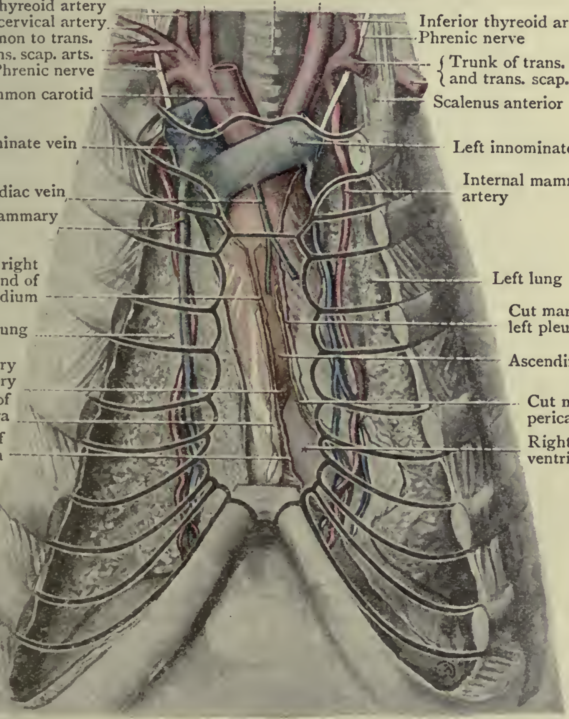


FIG. 27.—Dissection of the Anterior Part of the Thorax. The sternum and costal cartilages were replaced in position after the dissection had been made. The right scalenus anterior is cut away from its insertion up to the level of the upper border of the subclavian artery.

vagi and phrenic nerves; and the thoracic duct. It was noted further that the mediastinum is separated, for descriptive purposes, into two main parts, the *superior* and the *inferior mediastinum*, by an imaginary plane which passes from the lower border of the manubrium anteriorly to the lower border of the fourth thoracic vertebra posteriorly; it has been noted also that the inferior mediastinum is separable into three parts: (1) the *anterior mediastinum*, anterior to the pericardium, (2) the *posterior mediastinum*, posterior to the pericardium, and (3) the *middle mediastinum*, occupied by the pericardium, the heart, the great vessels immediately adjacent to the heart, and portions of the phrenic nerves, with their accompanying vessels. These sections of the mediastinum and their contents must now be examined in detail.

Dissection.—The remains of the superior and anterior mediastinal parts of the pleura must be divided longitudinally, immediately posterior to the sternum, from the lower end of the thorax to the apices of the pleural sacs. The sternal extremities of the first ribs must be then cut through, close to the manubrium sterni, and, at the same time, the sternal heads of the sterno-mastoid muscles must be separated from the manubrium, if that has not already been done by the dissector of the head and neck. After the sterno-mastoid muscles and the first ribs are divided, the sterno-hyoid and sterno-thyreoid muscles must be cut through transversely, as close to the upper margin of the manubrium as possible. Next, the body of the sternum must be separated from the xiphoid process and the tips of the seventh costal cartilages. The sternum with the attached costal cartilages may then be removed and placed aside, but it must be carefully preserved for future use.

When the sternum is removed the mediastinum is exposed from the front. As seen from the front, the superior mediastinum, which lies posterior to the manubrium, is a relatively wide triangular area, with its apex below. The anterior mediastinum, on the other hand, is merely a narrow cleft between the adjacent anterior margins of the pleural sacs, except opposite the anterior end of the left fifth costal cartilage, where the left pleural sac deviates slightly to the left and the anterior mediastinum becomes slightly wider (Fig. 27).

The anterior parts of both the superior and the anterior mediastina are occupied by areolar tissue in which, as far down as the third or fourth costal cartilages, remains of the thymus may be found. It may be recognised by its position and by the relative firmness of its substance (Figs. 22, 23).

Thymus.—The thymus is a bilobed organ, developed from the third visceral pouches. It is well developed in the fœtus and in the child until the end of the second year. Then it frequently undergoes atrophy, but it may persist even until old age.

Dissection.—Remove the thymus and the remains of the mediastinal pleura and clean the anterior contents of the superior mediastinum and the pericardium. Commence with the right innominate vein and trace it from the upper aperture of the thorax to its termination in the superior vena cava. It is joined at its commencement, in the angle between the internal jugular and subclavian veins, by the right lymph duct; posteriorly by the vertebral vein, and a vein from the first intercostal space; anteriorly, by the internal mammary vein and sometimes on its medial side by the right inferior thyreoid vein. Identify and clean as many of these tributaries as possible. Next clean the longer left innominate vein, which passes obliquely across the superior mediastinum along the upper margin of the aortic arch. Joining it at its commencement in the angle between the left internal jugular vein and left subclavian vein is the thoracic duct. The left inferior thyreoid vein enters its upper border. The left vertebral vein and a vein from the first left intercostal join it posteriorly near its commencement. The left superior intercostal vein, the left internal mammary vein, and some small pericardiac and thymic tributaries enter its lower border. The internal mammary and superior intercostal veins have already been identified (see pp. 15, 42); the others should now be secured if possible and all should be cleaned.

Not uncommonly the right and left inferior thyreoid veins unite at the root of the neck to form a common trunk which terminates frequently in the left innominate vein, but it may end in the junction of the two innominate veins or in the right innominate vein.

Venæ Anonymæ.—The innominate vein of each side is formed, posterior to the sternal end of the corresponding clavicle, by the union of the internal jugular and subclavian veins of the same side; and it ends, at the lower border of the right first costal cartilage, by uniting with its fellow of the opposite side to form the superior vena cava.

The *right innominate vein* is short and its course is almost vertical (Figs. 15, 27). It is accompanied on its medial side by the innominate artery, on its lateral side by the right phrenic nerve, and posteriorly by the right vagus nerve (Figs. 22, 23, 29). Antero-laterally it is in relation in the thorax with the anterior margin of the right pleura.

The *left innominate vein* is much longer than the right. It passes obliquely to the right and downwards, posterior to the upper half of the manubrium sterni; it lies posterior to the remains of the thymus and the lower ends of the sterno-hyoid and sterno-thyreoid muscles, and anterior to the three great branches of the aortic arch and the left phrenic and vagus nerves (Figs. 22, 27, 29).

Tributaries.—(1) The internal jugular vein, (2) the subclavian vein, (3) the vertebral vein, (4) the internal mammary vein, (5) the highest intercostal vein, and frequently (6) the inferior thyreoid vein of the same side. In addition, the right innominate vein receives the right lymph duct, or lymph vessels from the head and neck, the upper extremity and the right half of the thorax of the same side; and the left innominate vein receives (*a*) the left superior intercostal vein, (*b*) some pericardiac and thymic veins, and (*c*) the thoracic duct.

Dissection.—After the innominate veins and their tributaries have been cleaned displace the left innominate upwards

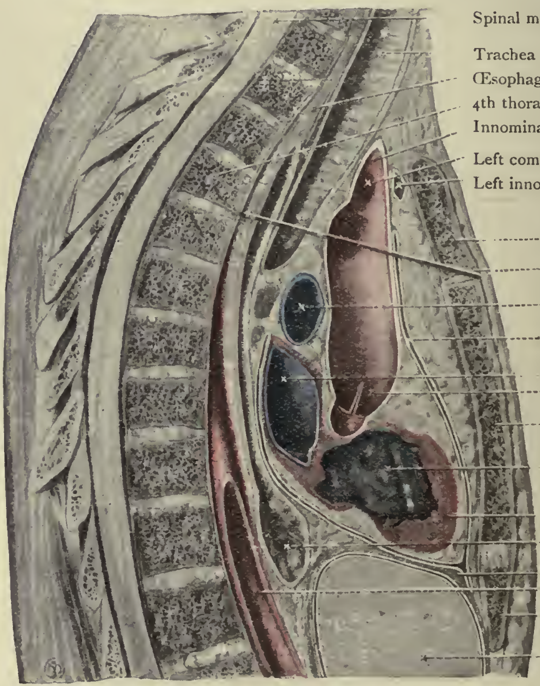


FIG. 28.—Sagittal section of the Thorax of an old man. The upper border of the manubrium sterni and the bifurcation of the trachea are lower than in the average adult.

or downwards, or divide it, as may be necessary, and clean the innominate artery from its origin from the arch of the aorta to its bifurcation into the right subclavian and right common carotid arteries. Next clean the left common carotid artery and the left subclavian artery, taking care not to injure the four nerves which descend between them, viz., the left phrenic nerve, the inferior cervical cardiac branch of the left vagus, the superior cervical cardiac branch of the left sympathetic trunk and the left vagus nerve, all of which have been identified in an earlier dissection (p. 35). When the three large branches of the arch of the aorta have been cleaned, clean the arch itself. Then carefully remove the areolar tissue which lies between the innominate and left common carotid arteries and display the anterior surface of the trachea. Occasionally a small artery, the *thyreoidea ima*, will be found ascending on the front of the trachea. It springs either from the arch of the aorta or from the innominate artery. Lastly, clean the areolar tissue from the anterior surface of the pericardium, and then proceed to the study of the structures exposed.

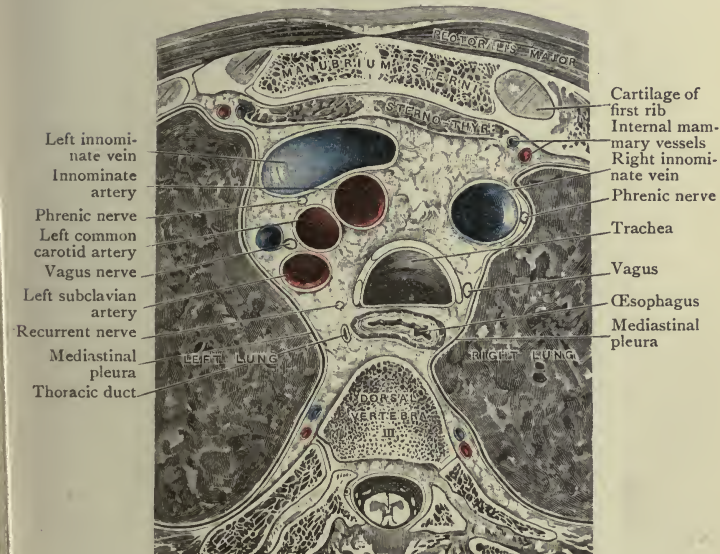


FIG. 29.—Transverse section through the Superior Mediastinum at level of the third thoracic vertebra.

Arteria Anonyma.—The innominate artery is the largest of the three great branches of the aortic arch. It commences, from the upper border of the arch, posterior and somewhat to the left of the centre of the manubrium sterni (Fig. 30), passes upwards and to the right, and terminates, posterior to the upper border of the right sterno-clavicular articulation, by dividing into the right common carotid and the right subclavian arteries (Fig. 27). Anterior to it are the manubrium sterni, with the attachments of the sterno-hyoid and thyreoid muscles, the right sterno-clavicular joint, the remains of the thymus, and the left innominate vein.

Posterior to its lower part is the trachea (Figs. 28, 29), but as the artery passes upwards and to the right it gains the side of the trachea and has the upper part of the right lung and pleura posterior to it. To its left, at its commencement, is the left common carotid artery, and at a

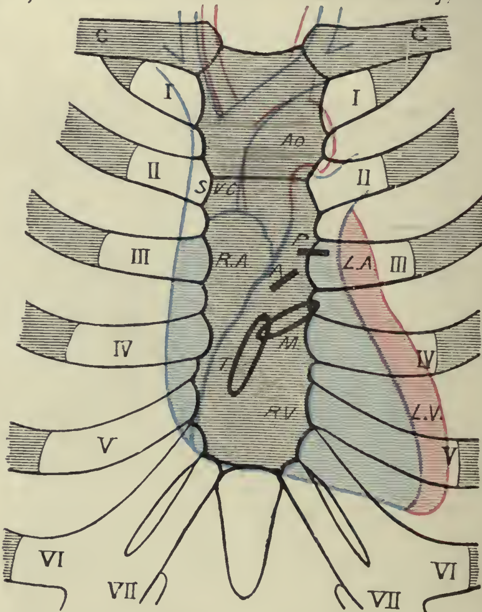


FIG. 30.—The relations of the Heart and of its Orifices to the Anterior Thoracic Wall.

I to VII. Costal cartilages.
A. Aortic orifice.
Ao. Arch of Aorta.
C. Clavicle.
LA. Left atrium.
LV. Left ventricle.
M. Mitral orifice.
P. Pulmonary orifice.
RA. Right atrium.
RV. Right ventricle.
SVc. Superior vena cava.
T. Tricuspid orifice.

higher level the trachea. On its right side is the right innominate vein, which separates it from the right phrenic nerve and the pleura. As a rule it gives off its terminal branches only, but occasionally a small artery, called the *thyreoidea ima*, springs from it.

Arteria Thyreoidea Ima.—This artery is frequently absent. When it is present it springs from the innominate artery, or from the arch of the aorta, and runs upwards, anterior to the trachea, to the thyreoid gland.

Arteria Carotis Communis Sinistra.—The left common carotid artery springs from the arch of the aorta, immediately to the left of, and slightly posterior to, the innominate artery. It passes upwards, through the superior mediastinum and posterior to the left sterno-clavicular joint, into the neck. Its *anterior relations* in the thorax are similar to those of the innominate artery. *Posterior to it*, from below upwards, are the trachea, the left recurrent nerve, the œsophagus and the thoracic duct, and, in a plane somewhat more to the left, the left phrenic and vagus nerves, and the left subclavian artery. *To its right* lie first the innominate artery, and then the trachea; and *to its left* is the left pleura. It gives off no branches in the thorax.

Arteria Subclavia Sinistra.—The left subclavian artery springs from the posterior part of the aortic arch, posterior to the left common carotid. It passes vertically upwards, through the superior mediastinum and posterior to the sternal end of the clavicle, into the root of the neck. *Anterior to it* are the left phrenic and vagus nerves, which separate it from the left common carotid artery. *Posterior*, and to its left side, it is in relation with the left mediastinal pleura and the lung. *To its right* side are the trachea and the left recurrent nerve, and, at a higher level, the œsophagus and the thoracic duct. It gives off no branches in the thoracic part of its course (Figs. 22, 29).

Dissection.—The lateral walls of the pericardium have already been exposed and opened (see p. 44); the flaps then made should be replaced and fixed in position with sutures. When that has been done, the outline of the sac will be fully displayed, and the dissectors can then study its relations to adjacent organs.

The Pericardium.—The pericardium is a fibro-serous sac which lies in the middle mediastinum. It surrounds the heart and the roots of the great vessels which enter and leave the heart.

The Fibrous Pericardium.—The fibrous or outer part of the pericardium is conical in form. *Its base* rests upon the diaphragm, principally upon the central tendon but also upon the muscular portion, particularly upon the left side. Near the median plane it is blended with the central tendon, and can be separated from it only by the aid of the edge of the scalpel; more laterally the areolar tissue which connects the pericardium and the diaphragm can be easily broken down by the use of the handle of the knife. The diaphragm separates the pericardium mainly from the upper surface of the liver, but also, towards the left and anteriorly, from the fundus of the stomach. *The apex* of the fibrous sac

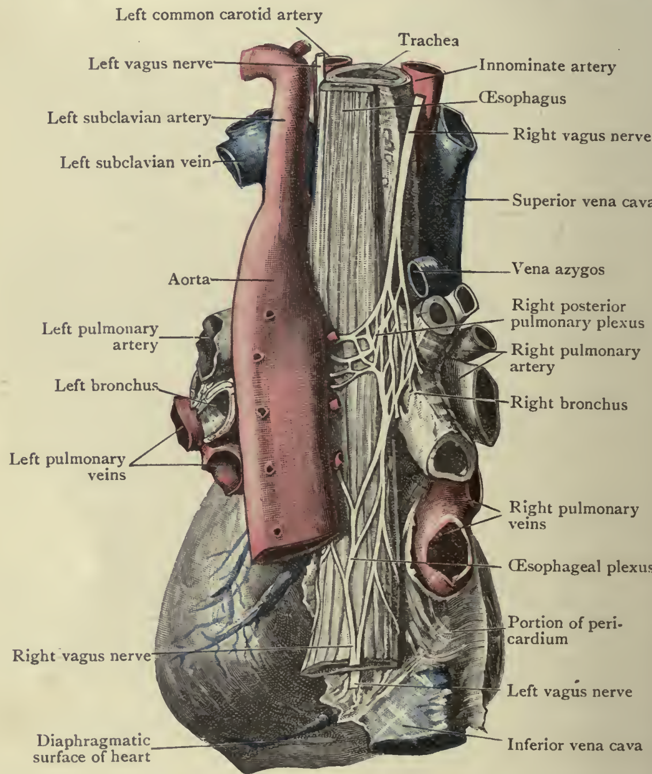


FIG. 31.—Posterior Aspect of the Heart, with the Descending Aorta, the Trachea and Bronchi, and the Œsophagus.

blends with the outer coats of the aorta, the pulmonary arteries and the superior vena cava. The *anterior surface* lies behind the body of the sternum and the cartilages of the ribs from the second to the sixth inclusive, but it is separated from them by the lungs and pleuræ, except (1) in the median plane of the anterior mediastinum, where condensations of the areolar tissue of the mediastinum, called the superior and inferior *sterno-pericardiac ligaments*, connect the anterior surface of the fibrous sac to the upper and lower ends of the body of the sternum respectively, and (2) in the region of the sternal extremity of the left fifth costal cartilage, where the left pleura retreats somewhat towards the left side, and the pericardium comes into direct relation with the sternum and the left transversus thoracis muscle. That portion of the pericardium is the so-called *bare area*. It is usually of small extent, and frequently it does not extend beyond the margin of the sternum, but it is of importance because through it the surgeon may attempt to tap the pericardium when the sac is distended with fluid.

Each *lateral wall* of the pericardium is in relation with the corresponding mediastinal pleura, the phrenic nerve and the pericardiaco-phrenic vessels intervening (O.T. comes nervi phrenici). The *posterior surface* lies anterior to the descending aorta and the œsophagus medially, whilst laterally it is supported posteriorly by the lungs and pleuræ (Fig. 21). At the junction of the upper parts of the lateral and posterior surfaces, on each side, two pulmonary veins enter the pericardium and receive sheaths from its fibrous wall.

Dissection.—When the relations and prolongations of the fibrous pericardium have been studied, the two anterior flaps already made in the lateral walls of the sac (see p. 44) should be connected together and converted into one large anterior flap. This can be done by a transverse cut, passing across the median plane just above the diaphragm. The large triangular flap thus formed should be thrown upwards towards the apex of the pericardium.

The Serous Pericardium.—The serous pericardium is a closed and invaginated sac which lines the inner surface of the fibrous sac and envelops the heart and the roots of the great vessels passing to and from the heart.

The uninvaginated portion of the wall of the serous sac, which lines the inner surface of the fibrous sac, is called the *parietal layer*, and the invaginated portion, which envelops the heart and more or less covers the roots of the great vessels, is the *visceral portion*. The inner surface of the sac is lined by a flat endothelium, which, during health, is smooth and glistening. The parietal and visceral layers are separated, during health, merely by a thin layer of serous fluid, which prevents friction between the two surfaces as they move over each other during the contractions and expansions of the heart.

The Sterno-costal Surface of the Heart.—Before the

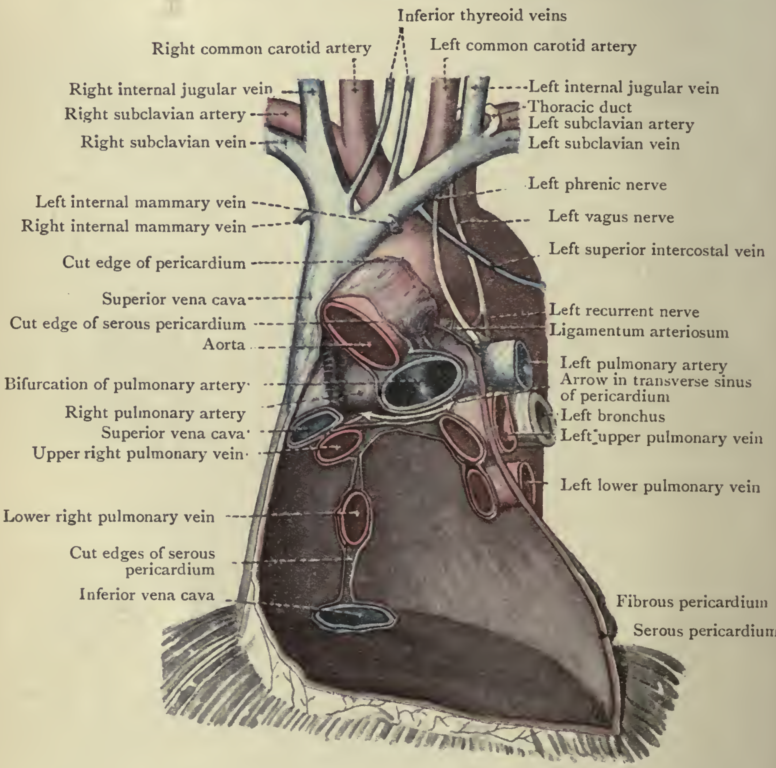


FIG. 32.—The Pericardium and Great Vessels of the Heart. The thoracic organs were hardened *in situ* by formalin injection. The pericardial cavity was opened by the removal of its anterior wall, the great vessels were divided and the heart was removed. The posterior wall of the oblique sinus is seen between the inferior vena cava and the right pulmonary veins on the right and the left pulmonary veins on the left.

dissectors disturb the heart, which has been exposed by the reflection of the anterior wall of the pericardium, they should note carefully not only the parts of the heart which are visible, but also their relations to the anterior wall of the thorax.

The latter they can easily do by replacing the sternum and costal cartilages in position from time to time.

They will find that the sterno-costal surface is divided into an upper and right, or atrial portion, and a lower and left, or ventricular portion by an oblique sulcus, called *the coronary sulcus* (O.T. *auriculo-ventricular*) (Figs. 33, 39), which is quite distinct below and on the right, but is masked above and to the left by the roots of the pulmonary artery and the aorta. The position of the coronary sulcus can be indicated on the surface of the body by a line extending obliquely downwards and to the right, from the sternal end of the third left to the sternal end of the sixth right costal cartilage. Below and to the left of the sulcus is the ventricular part of the sterno-costal surface, terminating on the left and below in the *apex* of the heart, which lies posterior to the fifth left intercostal space or to the left sixth rib, three and a half inches from the median plane. The ventricular area of the sterno-costal surface is divided by the anterior longitudinal sulcus (O.T. anterior interventricular sulcus) into a right two-thirds, formed by the right ventricle, and a left third, formed by the left ventricle. The anterior longitudinal sulcus terminates on the lower border of the sterno-costal surface, to the right of the apex, in a slight notch. The apex, therefore, is formed entirely by the left ventricle. The lower margin of the sterno-costal surface lies on the diaphragm. It is formed chiefly by the lower border of the right ventricle, and only to a small extent by the apical part of the left ventricle.

The upper and right portion of the sterno-costal surface is formed by the atria, which are to a large extent concealed by the pulmonary artery and the ascending part of the aorta. Above and to the right is the right atrium, continuous above with the superior vena cava and below with the inferior vena cava (Fig. 33), whilst its auricular portion (O.T. auricular appendage) curves upwards and to the left, along the line of the coronary sulcus, to the root of the pulmonary artery.

Crossing the front of the right atrium, immediately below the lower end of the superior vena cava, is a sulcus, called the *sulcus terminalis*. If the heart is pulled a little over to the left, this sulcus can be traced downwards, along the lateral aspect of the right atrium, to the anterior aspect of the upper end of the inferior vena cava. It indicates the separation between the cavity of the atrium proper and the venous sinus of the atrium, into which the great veins open.

The whole of the right border of the heart is formed by the right atrium. Its position can be indicated on the surface

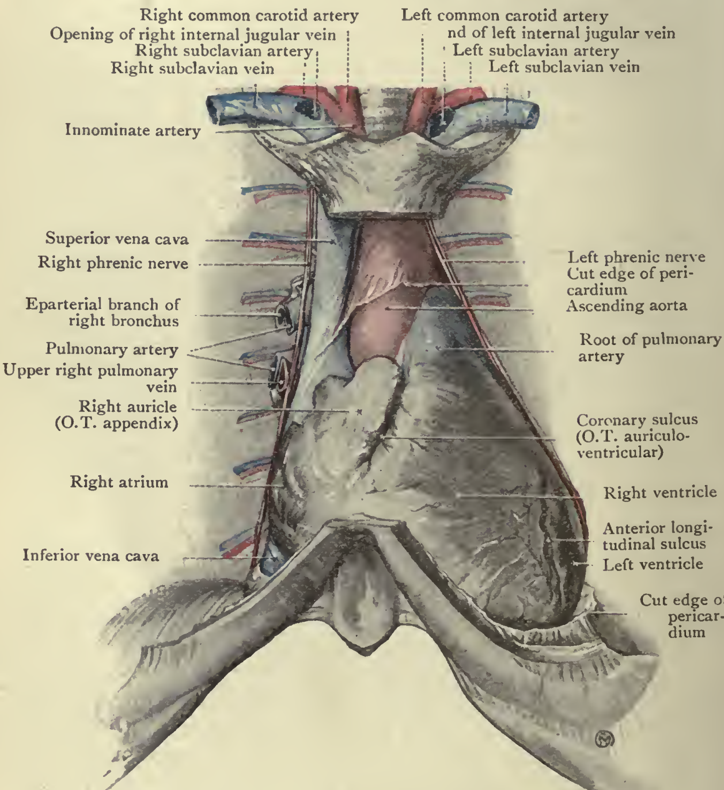


FIG. 33.—Dissection of the Middle and Superior Parts of the Mediastinum from the anterior aspect.

by a line, convex to the right, which commences at the level of the third right costal cartilage, half an inch from the sternum, and terminates opposite the sixth right cartilage at the same distance from the right margin of the sternum.[1] At

[1] When the right side of the heart is distended the lower end of the right border of the right atrium descends to the back of the seventh right costal cartilage.

the upper and left corner of the atrial area is the apex of the auricle of the left atrium (O.T. auricular appendage), and between the two auricles are the roots of the pulmonary artery and the aorta, the former anterior to the latter. The rounded portion of the upper part of the right ventricle, immediately below the pulmonary artery, is called the *conus arteriosus*.

If the pulmonary artery and the ascending part of the aorta were removed the upper parts of the anterior surfaces of the right and left atria, which lie behind the arteries, would be exposed, and the upper border of the heart, which is formed by the two atria, could be seen (Figs. 37). The two large vessels must not, however, be interfered with at present. Nevertheless, the dissectors should investigate the cleft which lies between the posterior surfaces of the arteries and the anterior surfaces of the atria. It is called the *transverse sinus of the pericardium* (Figs. 32, 37).

To find the transverse sinus pass a finger across the front of the lower part of the superior vena cava and behind the ascending aorta, then push it to the left until it emerges between the left side of the pulmonary artery and the auricle of the left atrium. The cleft through which the finger has passed is the transverse sinus. As the finger lies in the transverse sinus it has in front of it the ascending aorta and the stem of the pulmonary artery, which are enclosed in a common sheath of the visceral part of the serous pericardium, and form the anterior boundary of the transverse sinus. Behind the finger lie the upper parts of the right and left atria, which form the posterior wall of the sinus. Below the finger, at the lower border of the sinus, the visceral pericardium is reflected forwards from the anterior surface of the atria to the posterior surface of the ascending aorta. And above the finger, at the upper margin of the sinus is the inferior surface of the right pulmonary artery covered by the visceral pericardium as it passes forwards from the upper borders of the atria to the posterior surface of the ascending aorta. In Fig. 37 which represents a sagittal section of a heart, in which the transverse sinus is cut across at right angles to its long axis, the various boundaries of the sinus are in apposition with one another, but their relative positions are quite obvious.

Whilst a finger is kept in the transverse sinus a pointer should be passed through the right and left pulmonary arteries. Introduce the pointer through the cut end of the right pulmonary artery, in the root of the right lung, and pass it to the left until it emerges from the cut end of the left pulmonary artery in the root of the left lung. The dissectors will note that, as the pointer traverses the pulmonary arteries, from right to left, it passes first posterior to the superior vena cava, and then along the upper border of the transverse sinus which runs parallel with the part of the upper border of the heart which is formed by the left atrium.

Leave the pointer which marks the levels of the right and left pulmonary arteries and the upper border of the heart in position, but withdraw the finger from the sinus. Now replace the sternum and costal cartilages and note that the pointer, which marks the position of the upper border of the heart, inclines slightly downwards, as it passes from left to right, along a line which extends from the lower border of the second left costal cartilage to the upper border of the third right costal cartilage. The position of the upper border of the heart can be indicated, therefore, on the anterior surface of the thorax by a line drawn from the lower border of the second left costal cartilage to the upper border of the third right costal cartilage, commencing and ending 13 mm. (about half an inch) from the margin of the sternum. The right two-thirds of the same line will indicate fairly correctly the position of the right pulmonary artery. The left third will similarly indicate the position of the medial part of the left pulmonary artery.

The left border of the anterior surface of the heart is formed, to a slight extent, by the left atrium, but mainly by the left ventricle. It is convex to the left and its position is marked, on the surface of the body, by a line which commences above at the lower border of the left second costal cartilage, half an inch from the sternum, and terminates below, at the apical point, in the fifth left intercostal space, or behind the left sixth costal cartilage.

Before proceeding further the dissector should summarise the information he has gained regarding the relationship of the apex of the heart and the borders of the sterno-costal surface of the heart to the anterior wall of the thorax.

The *upper border* is formed by the atria, and, as the heart lies *in situ*, it is concealed to a great extent by the aorta and the pulmonary artery. Its position is marked on the surface by a line extending from the lower border of the second left to the upper border of the third right costal cartilage, commencing and terminating 13 mm. (about half an inch)

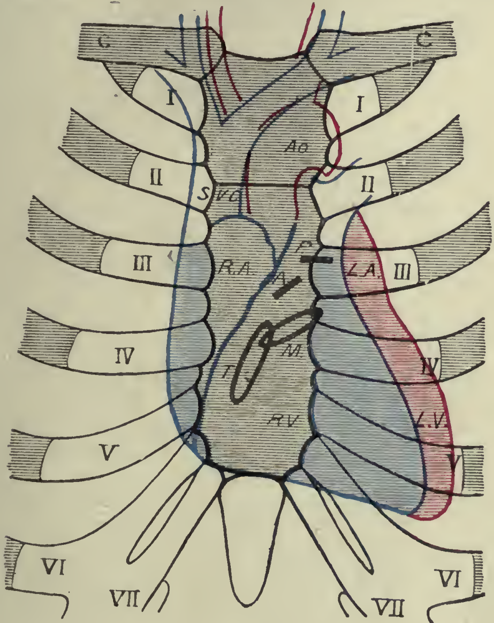


FIG. 34.—The relations of the Heart and of its Orifices to the Anterior Thoracic Wall. (Young and Robinson.)

I to VII. Costal cartilages.
A. Aorta.
Ao. Arch of Aorta.
C. Clavicle.
LA. Left atrium.
LV. Left ventricle.
M. Mitral orifice.
P. Pulmonary orifice.
RA. Right atrium.
RV. Right ventricle.
SVc. Superior vena cava.
T. Tricuspid orifice.

from the margins of the sternum. The *right border* is formed entirely by the right atrium, and its position is indicated on the surface by a line, convex to the right, commencing above at the upper border of the third right costal cartilage 13 mm. (half an inch) from the side of the sternum, and terminating below at the sixth right cartilage 13 mm. (half an inch) from its junction with the sternum. More than two-thirds of the *lower border* are formed by the right ventricle, and the remainder by the apical portion of the left ventricle, and the two parts may be separated by a distinct notch. The lower border is slightly concave downwards, in correspondence with the upward convexity of the diaphragm on which it rests, and it has a slight inclination downwards and to the left. It is marked, on the surface of the body, by a line extending from the sixth right costal cartilage, near the sternum, to the apical point, which lies in the left fifth intercostal space, or behind the left sixth costal cartilage, from 80-85 mm. ($3\frac{1}{4}$ to $3\frac{1}{2}$ inches) from the median plane. The left border, which is formed mainly by the left ventricle and only to a slight extent by the left atrium, extends from the apex to a point on the lower border of the left second costal cartilage 13 mm. (half an inch) from the margin of the sternum (Figs. 33, 34, 35).

The coronary sulcus, which indicates the plane of union of the atria and ventricles and, therefore, the plane of the atrio-ventricular and aortic and pulmonary orifices of the heart, can be indicated, on the surface, by a line extending from the sternal end of the third left costal cartilage to the sternal end of the sixth right cartilage. Posterior to the left extremity of that line, at the level of the upper part of the third left costal cartilage, is the pulmonary orifice of the heart. The aortic orifice is a little lower and slightly to the right, posterior to the sternum at the level of the lower border of the third left cartilage. Immediately below the aortic orifice, posterior to the left margin of the sternum, at the level of the upper part of the fourth left cartilage, lies the mitral orifice; and the tricuspid orifice is situated posterior to the middle of the sternum, opposite the fourth intercostal spaces. The positions of the great orifices cannot be confirmed at this stage of the dissection, and they will be noted again, at a later period, when the heart is opened.

After the sterno-costal aspect of the heart, the boundaries of the transverse sinus, and the general position of the heart have been studied, the dissectors should turn the apex of the heart upwards and to the right, and examine the inferior and posterior surfaces whilst the heart is still *in situ*. They will find that the *inferior* or *diaphragmatic surface*, which rests upon the diaphragm, is slightly concave; that it is formed entirely by the ventricles, and mainly by the left ventricle, which forms the left two-thirds, the separation between the ventricles being indicated by the *inferior longitudinal sulcus.* As the apex of the heart is held upwards and to the right, the dissector should note that a recess of the pericardial cavity ascends behind the *base* or *posterior surface* of the heart. That recess is the *oblique sinus* of the

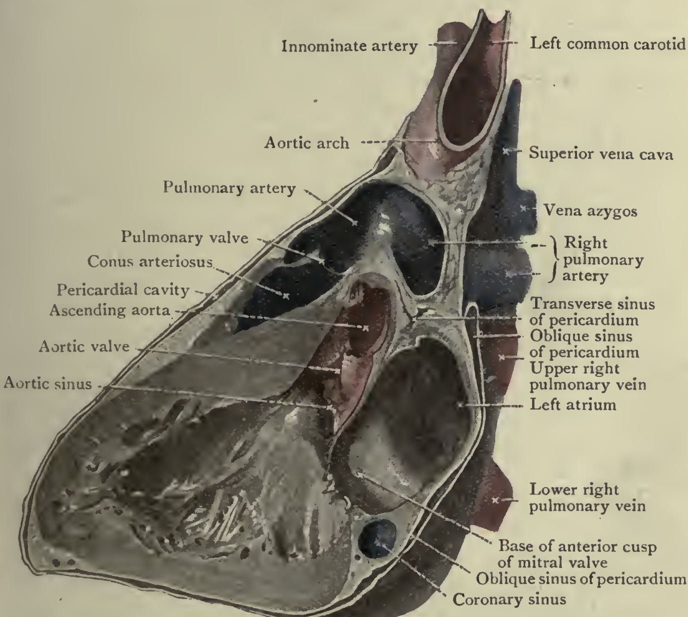


FIG. 37.—Sagittal section of Heart.

pericardium. Its orifice is below, where it is bounded to the right and below by the upper end of the inferior vena cava, and to the left and above by the inferior left pulmonary vein (Fig. 32). The posterior boundary of the sinus is the pericardium; and the pericardium separates the cavity of the sinus from the œsophagus, which, in this region, especially at its lower part, is lying between the pericardium and the descending part of the thoracic portion of the aorta. Both the œsophagus and the aorta can be palpated through the posterior wall of the sinus. The anterior wall of the oblique sinus is the posterior wall of the left atrium (Fig. 37). If the dissector passes his left index finger into the transverse sinus and the middle and index fingers of his right hand into the oblique sinus, he will be able to convince himself that the left atrium is the only structure which intervenes between the cavities of the two sinuses. When he has satisfied himself regarding this point, he should note that the lower and posterior part of the coronary sulcus of the heart extends across the lower part of the base between the posterior end of the left ventricle and the lower end of the left atrium, and that it is occupied by the coronary blood sinus, which opens into the right atrium immediately to the left of the upper end of the inferior vena cava.

A complete examination of the base of the heart cannot be made until the heart is removed from the thorax at a later stage of the dissection, and the dissectors should pass now to a consideration of the relation of the serous layer of the pericardium to the great vessels which are entering or leaving the heart (see Fig. 32). They have previously noted (p. 73) that the visceral layer of the serous portion of the pericardium covers almost every portion of the heart, the only part left uncovered being the upper border of the left atrium, which is in contact with the lower border of the right pulmonary artery.

To demonstrate again the lines of reflection of the visceral into the parietal part of the serous pericardium, seize the apex of the heart with the left hand and lift it upwards. Then pass the fingers of the right hand along the visceral layer on the inferior surface of the heart and upwards along the posterior surface of the left atrium to the upper margin of the oblique sinus, where, immediately below the right pulmonary artery, the visceral layer passes backwards and joins the parietal layer on the inner surface of the posterior wall of the pericardium. Follow the parietal layer on the posterior wall of the pericardium downwards with the fingers. At the inferior end of the posterior wall they will be carried forwards on the inner surface of the inferior wall, or base, of the pericardium to the anterior wall, which should be temporarily replaced in position. Then they must pass upwards along the anterior wall, to the level of the upper parts of the ascending aorta and the pulmonary artery, where the parietal layer of the serous pericardium is reflected from the fibrous layer of the pericardium on to the walls of the aorta and the pulmonary artery, and the fingers, following it, will pass downwards on the two great arteries and along the fronts of the ventricles to the inferior border of the anterior surface, so completing the circuit of the heart in the sagittal plane, and demonstrating that it is covered on the posterior, inferior and anterior surfaces by the serous layer of the pericardium.

It has been noted, previously, that the upper parts of the anterior surfaces of the atria are concealed by the ascending aorta and the stem of the pulmonary artery, from which they are separated by the transverse sinus. It must be noted now that the visceral layer of the serous pericardium which surrounds the cavity of the transverse sinus covers the posterior surfaces of the aorta and the stem of the pulmonary artery, that it passes backwards from them across the inferior surface of the right pulmonary artery and then downwards on the anterior surface of the left atrium. It is immediately behind the latter reflection that the upper border of the atrium is not covered by serous pericardium in the angle between the transverse sinus and the upper end of the oblique sinus. (See Fig. 59, in which the prolongation upwards of the fibrous layer of the pericardium on to the back of the right pulmonary artery has been removed.) The fact that a finger can be passed through the transverse sinus posterior to the aorta and the pulmonary artery, but that it cannot be insinuated between the two vessels, will indicate to the dissectors that the two great arteries are enclosed in a tubular sheath of the visceral part of the serous membrane.

An examination of the venæ cavæ will show that the lower inch of the superior vena cava lies within the fibrous pericardium and that it is ensheathed, except along its postero-medial border, by a covering of the serous layer, whilst the inferior vena cava can scarcely be said to have any intra-pericardial course, for it joins the lower and posterior part of the right atrium immediately after piercing the fibrous layer, but the margin of the orifice by which it enters is surrounded by the serous layer except along a narrow line posteriorly (Fig. 32). The left pulmonary veins are covered by the serous layer on their superior, anterior, and inferior aspects, but not posteriorly; and the right pulmonary veins, which enter the left atrium as soon as they have pierced the fibrous pericardium, are in relation with the serous layer merely along the medial and lateral borders of the orifices in the fibrous layer through which they enter.

Dissection.—**After the examination of the reflections of the serous layer of the pericardium is completed, the dissectors should study the vessels and nerves which supply the walls of the heart. They are the coronary arteries and the cardiac veins and nerves, and they lie in the coronary and longitudinal sulci of the heart, which have been noted already. To display them the visceral pericardium superficial to them must be cut and turned aside ; the fat which lies in the sulci around the vessels must be removed ; then the main vessels can be traced to their origins and terminations, and an endeavour should be made to preserve the fine nerves which accompany the vessels.**

Arteriæ Coronariæ.—The coronary arteries are the nutrient vessels of the heart. They spring from dilatations of the commencement of the aorta which are called the *sinus aortæ* (Valsalva). There are three sinuses of the aorta, an anterior and two posterior, and only two coronary arteries, a right and a left; the right artery springs from the anterior sinus, and the left from the left posterior sinus (Figs. 20, 38).

The *right coronary artery* passes forwards from the anterior aortic sinus, between the pulmonary artery and the auricle of the right atrium; turns downwards and to the right, in the coronary sulcus, to the lower part of the right margin of the heart, round which it curves. Then it proceeds to the left, in the posterior part of the coronary sulcus, till it reaches the posterior end of the inferior longitudinal sulcus, where it divides into a small transverse and a large interventricular branch. The *transverse branch* continues to the left, in the coronary sulcus, till it anastomoses with the circumflex branch of the left coronary artery. The *interventricular branch* runs forwards in the inferior longitudinal sulcus on the diaphragmatic surface of the heart, and it anastomoses with the interventricular or descending branch of the left coronary artery at the cardiac notch on the lower margin of the heart. In addition to its terminal branches, the right coronary artery supplies branches to the roots of the pulmonary artery and the aorta, and to the walls of the right atrium and the right ventricle, the larger and more numerous branches being given to the ventricle. One of the latter, the *marginal branch*, passes along the inferior margin of the heart towards the apex of the ventricle (see Fig. 39).

The *left coronary artery* springs from the left posterior aortic sinus (Fig. 38). It lies, at first, posterior to the pulmonary artery, and runs towards the left for a short distance. Then it turns forwards, between the pulmonary artery and the auricle of the left atrium (Fig. 20), and divides into a descending or interventricular, and a circumflex branch.

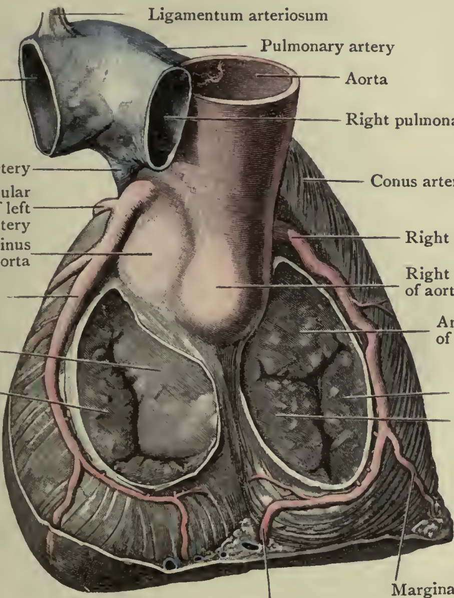


FIG. 38.—The Base of the Ventricular Part of the Heart, from which the Atria have been removed. The detached atria are depicted in Fig. 41. The specimen was hardened *in situ*.

The *interventricular branch* passes downwards along the sterno-costal surface of the heart, in the anterior longitudinal sulcus (Fig. 39), and, after turning round the lower border of the heart, in the cardiac notch, it anastomoses with the interventricular branch of the right coronary artery. The *circumflex branch* runs to the left, in the coronary sulcus, turns round the left border of the heart (Fig. 38), and anastomoses, in the posterior part of the coronary sulcus, with the transverse terminal branch of the right coronary artery.

From the stem of the left coronary artery twigs are given to the roots of the pulmonary artery and the aorta, and its terminal branches supply the walls of both ventricles and the walls of the left atrium.

The dissectors should note that the two coronary arteries are the only arteries which supply blood to the walls of the

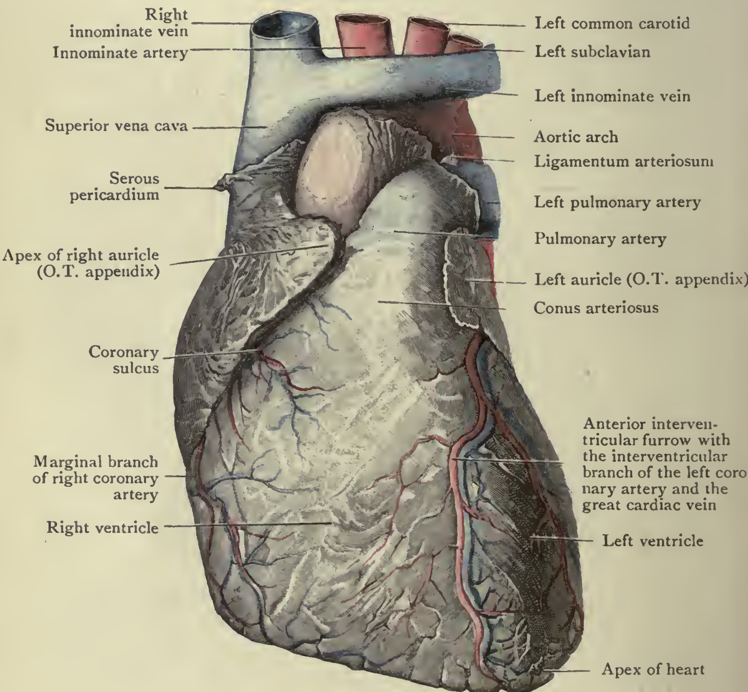


FIG. 39.—Sterno-costal Surface of the Heart.

heart, and that they form no effective anastomoses with any other arteries. Therefore, if they are obliterated, the blood supply to the walls of the heart is stopped and death must ensue. Occasionally there are three coronary arteries, one from each aortic sinus, and sometimes there is only one coronary artery, which may be either the right or the left.

Venæ Cordis.—The cardiac veins are: (1) the coronary sinus; (2) the great cardiac vein; (3) the inferior (posterior) ventricular vein ; (4) the middle cardiac vein ; (5) the oblique vein ; (6) the small cardiac vein ; (7) the anterior cardiac veins ; and (8) the venæ cordis minimæ.

The *coronary sinus* lies at the base of the heart, in the posterior part of the coronary sulcus, between the inferior border of the left atrium and the posterior border of the left ventricle. It can be displayed when the apex of the heart is turned upwards and to the right. Its right extremity opens into the right atrium, immediately to the left of the orifice of the inferior vena cava (Figs. 41, 44). At its left

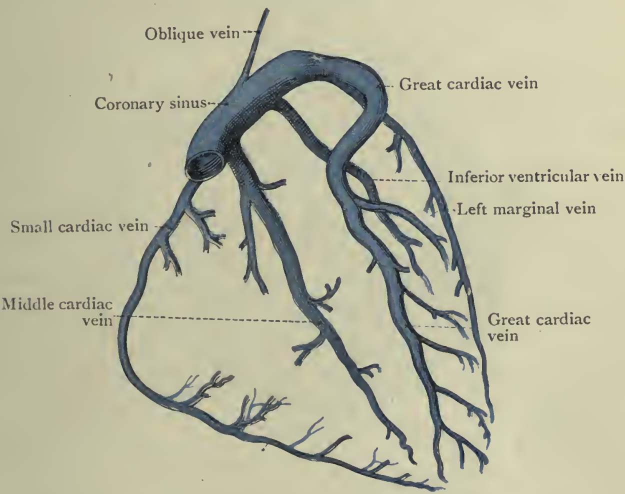


FIG. 40.—The Coronary System of Veins on the Surface of the Heart. (Diagram.)

extremity it receives the great cardiac vein. The *great cardiac vein* ascends along the anterior longitudinal sulcus (Fig. 39), where it lies in relation with the interventricular branch of the left coronary artery. At the upper end of the interventricular sulcus it turns round the left border of the heart, with the circumflex branch of the left coronary artery, and it ends in the left extremity of the coronary sinus. The *inferior ventricular vein* or veins, from the diaphragmatic surface of the left ventricle, and the *middle cardiac vein*, which runs backwards in the inferior longitudinal sulcus, end in the lower border of the coronary sinus. The *oblique vein* descends on the posterior wall of the left atrium and ends in the upper border of the coronary sinus. The *small cardiac vein* (O.T. *right coronary*) runs along the lower margin of the heart with the marginal branch of the right coronary artery,

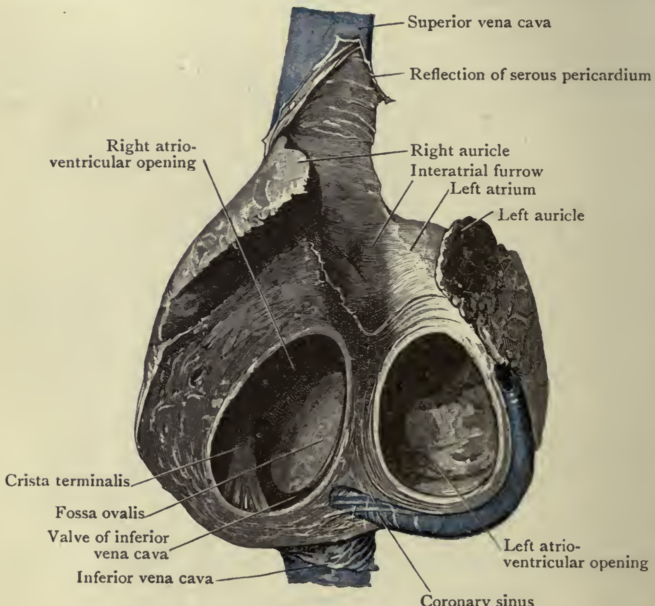


FIG. 41.—The Anterior Aspect of the Atrial Part of the Heart. The atria have been removed from the ventricles. The ventricular portion of the same heart is depicted in Fig. 38. The specimen was hardened *in situ.*

curves round the right border of the heart, in the coronary sulcus, and ends in the right extremity of the coronary sinus.

The *anterior cardiac veins* are small vessels which ascend along the anterior surface of the right ventricle and terminate directly in the lower and anterior part of the right atrium. The *venæ cordis minimæ* are small veins which pass from the substance of the heart, and more particularly from the walls of the right atrium and ventricle, and open, by small orifices, into the cavity of the right atrium. The orifice through which the great cardiac vein opens into the coronary sinus is usually provided with a valve; the orifice of the small cardiac vein may be provided with a valve, but the orifices of the other tributaries of the sinus are generally devoid of valves.

Nervi Cordis.—The coronary plexuses, from which the nerves of the heart are directly derived, are offshoots of the superficial and deep cardiac plexuses. The superficial cardiac plexus has already been investigated (p. 56). It lies below the arch of the aorta and above the bifurcation of the pulmonary artery, at the right side of the ligamentum arteriosum. The deep cardiac plexus, which is situated between the posterior surface of the arch of the aorta and the front of the bifurcation of the trachea, will be dissected later (p. 129).

The *right coronary plexus* is formed by twigs from the superficial cardiac plexus which descend along the pulmonary artery, and by additional fibres from the deep cardiac plexus. It is distributed along the course of the right coronary artery. The *left coronary plexus*, which accompanies the artery of the same name, is derived from the deep cardiac plexus. The nerves do not slavishly follow the arteries; they soon leave the vessels, and are ultimately lost in the substance of the heart. Here and there ganglia are developed in connection with them.

Dissection.—The chambers of the heart and the great vessels which communicate with them should now be examined, as far as possible, whilst the heart is still *in situ*, so that the relations of the various orifices to the sternum and costal cartilages can be verified. Examine first the right atrium and the venæ cavæ, then the right ventricle and the pulmonary artery, and afterwards the left ventricle and the ascending part of the aorta, which springs from it. The examination of the left atrium, and the terminations of the pulmonary veins, cannot be conveniently undertaken until the heart and the pericardium have been removed from the body (see p. 119).

Open the *right atrium* by means of the following incision. Enter the knife at the apex of the auricle of the atrium (O.T. auricular appendix) and carry it backwards, close to the upper border of the auricle, across the sulcus terminalis and through the lateral wall of the atrium, to the posterior border of the lower end of the superior vena cava; then downwards, posterior to the sulcus terminalis, to the inferior vena cava; and, finally, forwards, across the lower end of the sulcus terminalis and above the anterior aspect of the upper end of the inferior vena cava, to the coronary sulcus. Throw the flap thus formed forwards, and clean the interior of the cavity with a sponge.

Atrium Dextrum (O.T. **Right Auricle**).—As the flap formed by the anterior and lateral walls of the right atrium is turned forwards a vertical ridge will be noted on its inner surface. It is the *crista terminalis*, which corresponds in position with the sulcus terminalis on the outer surface. It marks the boundary between the anterior part of the atrium, the *atrium proper*, and the posterior part, which

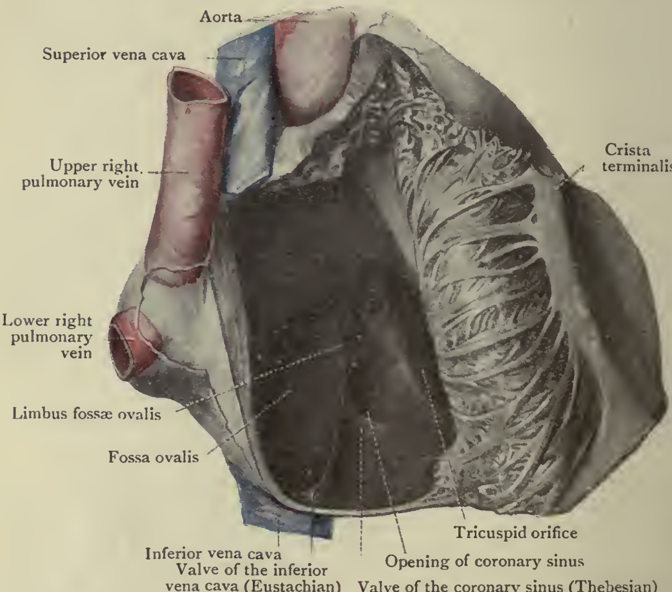


FIG. 42.—The Right Atrium. Part of the posterior wall and the whole of the right lateral and anterior walls have been turned forwards.

is known as the *sinus venarum* because the great veins of the body and heart open into it (Figs. 42, 43). The two parts of the cavity differ, however, not only in position and their relations to the great veins, but also in the characters of their walls. The whole of the interior of the atrium presents a polished glossy appearance, due to the endocardial lining; but, whilst the wall of the sinus venarum is smooth, the rest of the wall of the atrium is rendered rugose by a large number of muscular ridges which commence at the crista terminalis and run forwards to the right margin of the atrium. The muscular ridges, on account of their somewhat parallel arrangement, are called the *musculi pectinati*.

The veins which open into the right atrium are the (1) superior vena cava, (2) inferior vena cava, (3) coronary sinus, (4) anterior cardiac veins, and (5) venæ cordis minimæ. The aperture by which the blood leaves it is the tricuspid orifice.

The *orifice of the superior vena cava* is in the upper and

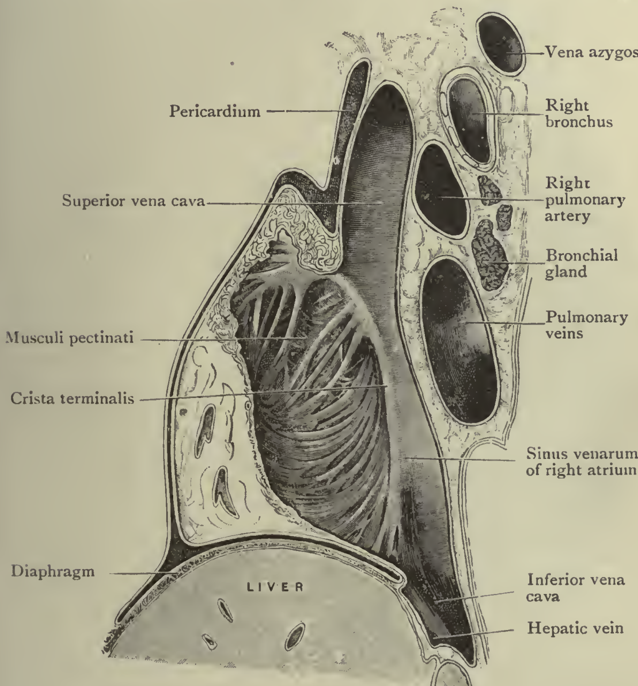


FIG. 43.—Sagittal section through the Right Atrium of the Heart and the Root of the Right Lung.

posterior part of the atrium, at the level of the third right costal cartilage.[1] It is entirely devoid of any valvular arrangement. Immediately below it, on the posterior wall of the atrium, in a well-fixed heart, will be found a rounded prominence,

[1] In the specimen shown in Fig. 46 it was at the level of the fourth costal cartilage.

the intervenous tubercle (Lower), which tends to throw the stream of blood entering the atrium by the superior vena cava downwards and forwards into the atrio-ventricular orifice.

The *orifice of the inferior vena cava* is in the lower and posterior part of the atrium, at the level of the sixth right costal cartilage[1] and the lower border of the eighth thoracic vertebra. Running along its anterior margin, and intervening between it and the atrio-ventricular opening, is the remnant of a valve, *the valve of the vena cava* (Eustachii). (Figs. 42, 44.) It terminates, to the left, in the lower end of a ridge, *limbus fossæ ovalis* (O.T. *annulus ovalis*), which lies on the inter-atrial septum and forms the anterior and upper boundary of a shallow fossa, the *fossa ovalis* (Figs. 42, 44). At the upper end of the fossa ovalis there was, during fœtal life, a foramen, the *foramen ovale*, through which the two atria communicated with each other. The object of the valve of the vena cava, which in fœtal life was much more perfect, was to direct the oxygenated inferior caval blood through the foramen ovale into the left atrium, whence

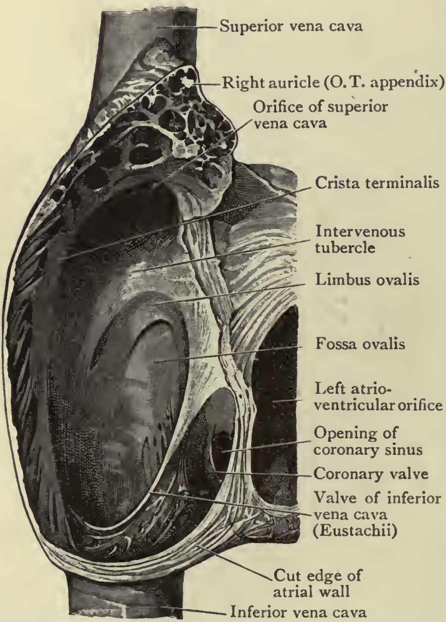


FIG. 44.—Interior of Right Atrium as seen by the removal of the anterior wall, or that wall opposed to the base of the Ventricles. This is a part of the same specimen that is depicted in Fig. 43.

[1] In the specimen shown in Fig. 46 it was at the level of the seventh costal cartilage.

it was passed into the left ventricle, and was then distributed, by the aorta, throughout the whole body.

During fœtal life it would have been useless for the blood to pass through the lungs, which were inactive and devoid of air. At the same time, had the oxygenated blood, which is poured into the upper part of the inferior vena cava by the vein from the placenta, passed through the right atrium into the right ventricle, it would have failed to reach the head and the upper extremities, for, leaving the right ventricle by the pulmonary artery, it would have entered the aorta through the ductus arteriosus beyond the origin of the left subclavian artery and, therefore, beyond the innominate and left common carotid arteries.

In many cases a small part of the foramen ovale persists in the adult. If it is present it will be found on the left of

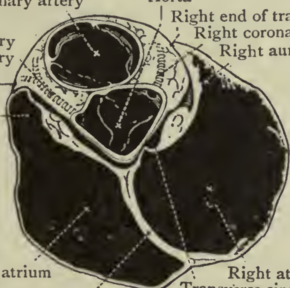


FIG. 45.—Transverse section through the Upper Part of the Heart.

the upper curved end of the limbus ovalis, and a probe should be passed through it into the left atrium.

The *opening of the coronary sinus* lies to the left of the lower end of the limbus ovalis and directly posterior to the tricuspid orifice, through which the right atrium communicates with the right ventricle (Figs. 42, 44). On its right margin lies a valvular fold, *the valve of the coronary sinus* (Thebesii), which turns the blood, flowing from left to right in the sinus, forwards into the atrio-ventricular orifice. The venæ cordis minimæ and the anterior cardiac veins open directly into the atrium by small orifices scattered irregularly over the walls.

The *tricuspid orifice* is in the lower and anterior part of the atrium. It opens forwards into the lower and posterior part of the cavity of the right ventricle, and is sufficiently large to admit the tips of three fingers. It is bounded by a fibrous ring to which the cusps of the right atrio-ventricular valve are attached. These cusps will be examined when the right ventricle is opened.

The Septum Atriorum and the Fossa Ovalis.—The inter-

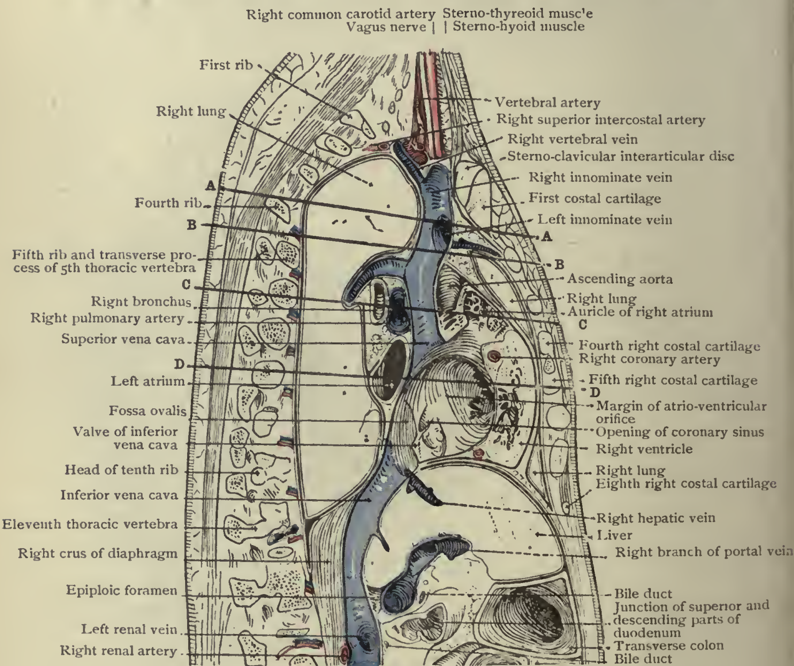


FIG. 46.—Sagittal section and partial dissection of the upper part of the trunk of a young Male Adult. The section is to the right of the median plane along the line of the superior and inferior venæ cavæ and it passes through the right margin of the left atrium of the heart. The atria were partially distended and the ventricles were contracted.

A-A	Plane of section of Fig. 47.
B-B.	,, ,, ,,
C-C.	,, ,, ,,
D-D.	,, ,, ,,

atrial septum is a fibro-muscular partition which intervenes between the right and left atria (Fig. 45). In the fœtus it is pierced by an obliquely directed foramen, the foramen ovale, already referred to; and in the adult it is marked on the lower and posterior part of its right side by a shallow depression, *the fossa ovalis*, which is bounded anteriorly and above by a muscular ridge, *the limbus ovalis*, whilst below and posteriorly it fades away into the orifice of the inferior vena cava.

The floor of the fossa ovalis is thin; it marks the situa-

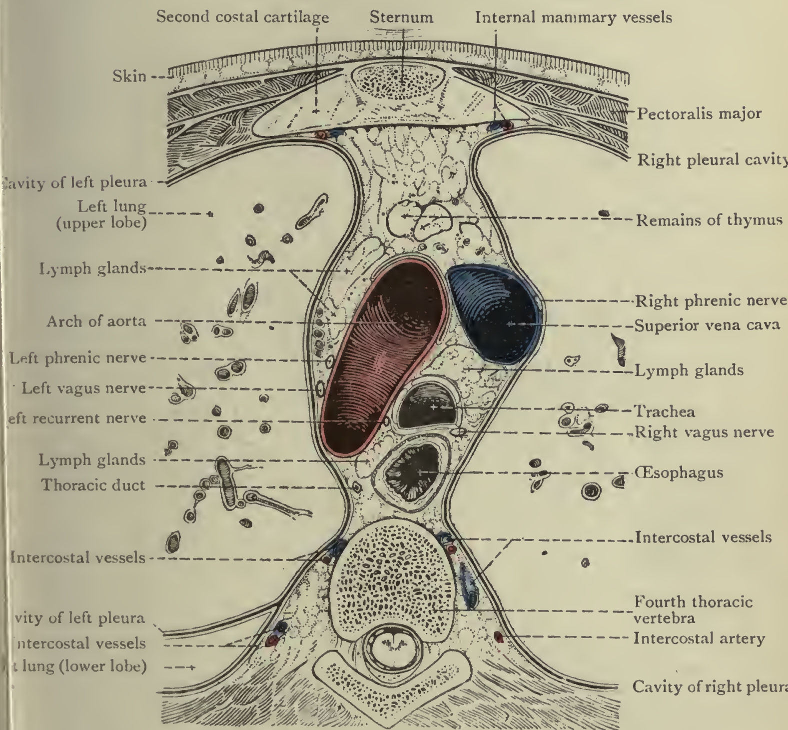


FIG. 47.—Transverse section of the Thorax of a Male Adult along the plane **B-B**, Fig. 46.

tion of the lower part of the boundary of the foramen ovale of the fœtus, and is formed by a portion of the interatrial wall which, in the fœtus, acted as a flap valve and prevented regurgitation of blood from the left to the right atrium.

Vena Cava Superior.—The superior vena cava returns to the right atrium the venous blood from the head and neck, the upper extremities, the walls of the thorax, and the upper parts of the walls of the abdomen. It commences, by the union of the right and left innominate veins, at the level of the lower border of the sternal end of the first right costal cartilage (Figs. 27, 32); and it terminates, in the upper and posterior part of the right atrium, at the level of the third

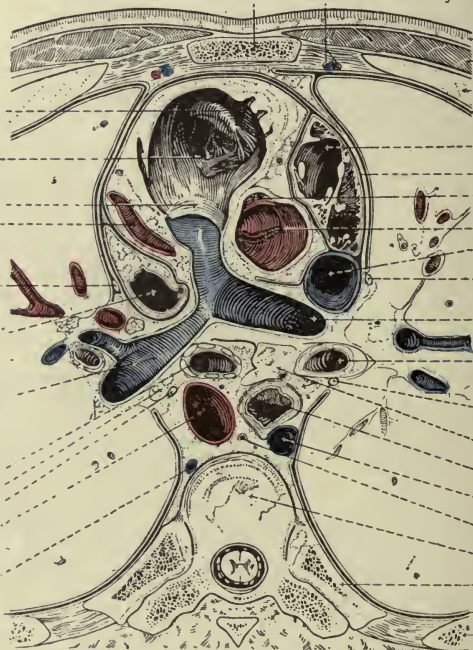


FIG. 48.—Transverse section through the Thorax of a young Male Adult along the plane **C-C**, Fig. 46.

right costal cartilage, at the right border of the sternum.[1] It lies partly in the superior and partly in the middle mediastinum, and its lower half is within the fibrous pericardium and is partly ensheathed by the serous pericardium (Fig. 32).

Tributaries.—The tributaries of the superior vena cava are the two innominate veins, by whose junction it is formed,

[1] In the specimen shown in Fig. 15 it terminated at the level of the fourth right costa cartilage.

and the vena azygos, which enters it immediately before it pierces the fibrous pericardium, at the level of the second right costal cartilage (Fig. 15).

Relations.—The superior vena cava lies to the right of, and somewhat posterior to, the ascending aorta. *Posterior to* its upper part are the right pleura and lung on the right, and the right vagus, trachea and the vena azygos on the left (Figs. 23, 57), and, at a lower level, the right bronchus, the right pulmonary artery (Fig. 20) and the upper right pulmonary vein pass behind it. *Anteriorly* and on the left it is overlapped by the ascending aorta, and on the right by the right pleura and lung. *On its left side*, above, is the lower end of the innominate artery, and below is the ascending aorta; and *on the right side* is the right pleura, with the phrenic nerve and the accompanying vessels intervening (Figs. 20, 56).

Vena Cava Inferior.—Only a small portion, about 18 mm. (three-quarters of an inch), of the inferior vena cava is found in the thorax. It ascends from the diaphragm along the mediastinal surface of the right pleura and lung, pierces the pericardium anterior to the lower border of the right ligamentum pulmonis, and immediately ends in the lower and posterior angle of the right atrium (Figs. 13, 15, 59).

Relations.—*Anterior to it* is the diaphragm; *posterior to it* the vena azygos, the greater splanchnic nerve and the thoracic duct; and *to its right* the phrenic nerve with its accompanying vessels and the right pleura and lung (see Fig. 11).

Dissection.—The cavity of the right ventricle should be opened by three incisions. The first should be made transversely across the upper end of the conus arteriosus, immediately below the commencement of the pulmonary artery. It should begin a little to the right of the upper end of the anterior longitudinal sulcus and terminate a little to the left of the coronary sulcus. The second must commence at the right end of the first and pass obliquely downwards and to the right, along the left margin of the coronary sulcus, to the inferior border of the heart. The third commences at the left end of the first, follows the line of the anterior interventricular sulcus, lying a little to its right side, and also terminates at the lower margin of the heart. After the triangular flap thus formed is turned downwards and to the right, the cavity of the ventricle should be cleaned with the aid of sponge and forceps. If the *moderator band* of muscle fibres, which connects the anterior wall of the ventricle with the interventricular septum, interferes with the necessary displacement of the flap it must be divided.

Ventriculus Dexter.—The cavity of the right ventricle has a triangular outline. The atrio-ventricular orifice opens into the lower and posterior angle, the pulmonary artery springs from the upper and posterior angle, and between the two orifices is a strong and rounded muscular ridge, *the supra-ventricular crest.* The supra-ventricular crest projects into the cavity of the ventricle, converting it into a U-shaped tube which commences posterior to and below the supra-ventricular crest,

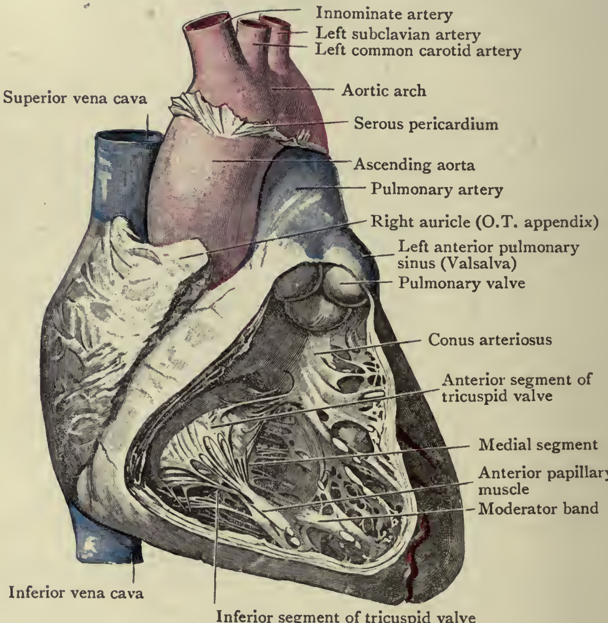


FIG. 49.—The Interior of the Right Ventricle.

runs forwards and to the left, towards the apex, and turns upwards and backwards, along the anterior part of the inter-ventricular septum and anterior to the supra-ventricular crest, to the orifice of the pulmonary artery.

On transverse section the cavity of the right ventricle is semilunar in outline, in consequence of the thick interventricular septum, which forms the left and posterior wall, bulging into the cavity (Fig. 50). Its walls are much thicker than the walls of the right atrium, but much thinner than the walls of the left ventricle (Fig. 50). The reason for the differences is obvious: the atrium has merely to force the blood through the wide atrio-ventricular orifice into the right ventricle, and the right ventricle has only to send the blood through the lungs to the left atrium; but the left ventricle has to force the blood through the whole of the trunk, the head and neck, and the limbs; and the muscular strength of the walls of the cavities of the heart is proportional to the work they have to do.

The portion of the right ventricle which ascends to the orifice of the pulmonary artery is the *conus arteriosus*. Its walls are smooth and devoid of projecting muscular bundles (Fig. 49); but the inner surface of the walls of the remaining part of the ventricle is rendered extremely irregular by the projection of a lace-work of fleshy ridges called *trabeculæ carneæ* (Figs. 49, 53). Some of the trabeculæ are merely ridges raised in relief upon the surface; others are attached to the wall at each extremity, but are free in the rest of their extent. The cavity of the ventricle is invaded, however, not only by the trabeculæ carneæ, but also by a number of conical muscular projections, the *musculi papillares*. The papillary muscles are attached by their bases to the wall of the ventricle, whilst their apices are connected, by a number of tendinous strands, called *chordæ tendineæ*, to the margins and the ventricular surfaces of the cusps of the atrio-ventricular valve. As a rule there is one large anterior papillary muscle attached to the anterior wall, a large inferior papillary muscle attached to the inferior wall, and a number of smaller papillary muscles attached to the septal wall. Occasionally the anterior and inferior muscles are repre-

FIG. 50.—Transverse section through the Ventricular Part of the Heart seen from above. (From Luschka.)

1. Cavity of right ventricle.
2. Cavity of left ventricle.
3. Ventricular septum.
4. Thick wall of left ventricle.
5. Thinner wall of right ventricle.
6. Inferior longitudinal (interventricular) sulcus with middle cardiac vein and interventricular branch of right coronary artery.
7. Anterior longitudinal (interventricular) sulcus with great cardiac vein and interventricular branch of left coronary artery.

sented by a number of smaller projections. It must be noted that the chordæ tendineæ from each papillary muscle, or group of papillary muscles, gain insertion into the margins and ventricular surfaces of two adjacent cusps of the valve. The result of the arrangement is, as the papillary muscles contract simultaneously with the contraction of the general wall of the ventricle, that the chordæ tendineæ hold the margins of the cusps together and at the same time prevent them being driven backwards into the atrium.

One of the trabeculæ carneæ, which is usually strong and well marked, passes across the cavity from the septum to the base of the anterior papillary muscle. It is called the *moderator band*. It tends to prevent over-distension of the cavity of the ventricle, by fixing the more yielding anterior wall of the ventricle to the more solid septum.

There is one opening of entrance into the right ventricle, the atrio-ventricular, and one opening of exit, the pulmonary orifice. Each is guarded by a valve.

The *right atrio-ventricular orifice* lies at the lower and posterior part of the right ventricle, its centre being behind the middle of the sternum at the level of the fourth intercostal space. It is about one inch in diameter, and is surrounded by a fibrous ring. It admits the tips of three fingers, and it is guarded by a valve which possesses three cusps, and is called, therefore, the *tricuspid valve*.

Valvula Tricuspidalis.—The three cusps of the tricuspid valve occupy definite positions :—one is anterior, another medial, and the third inferior. The anterior cusp intervenes between the atrio-ventricular orifice and the conus arteriosus. The medial cusp lies in relation with the septal wall; and the inferior cusp with the inferior wall of the ventricle. Occasionally small additional cusps are interposed between the three main cusps.

The bases of the cusps are attached to the fibrous ring round the margin of the orifice. Their apices, margins and ventricular surfaces are attached to the chordæ tendineæ. Their atrial surfaces, over which blood flows as it enters the ventricle, are smooth, and their ventricular surfaces are more or less roughened by the attachment of the chordæ tendineæ, but the roughening is less marked on the ventricular surface of the anterior cusp over which the blood flows as it passes through the conus arteriosus to the pulmonary orifice.

The Atrio-ventricular Bundle.—The atrio-ventricular bundle is a small bundle of peculiar muscle fibres, of pale colour, which forms the only direct muscular connection between the walls of the atria and the ventricles (see p. 121). To expose it, the anterior part of the medial cusp of the tricuspid valve must be detached from the fibrous atrio-ventricular ring. When that has been done, the membranous upper part of the interventricular septum will be exposed, and the atrio-ventricular bundle will be found running along its posterior and lower border to the upper end of the muscular part of the interventricular septum, where it divides into right

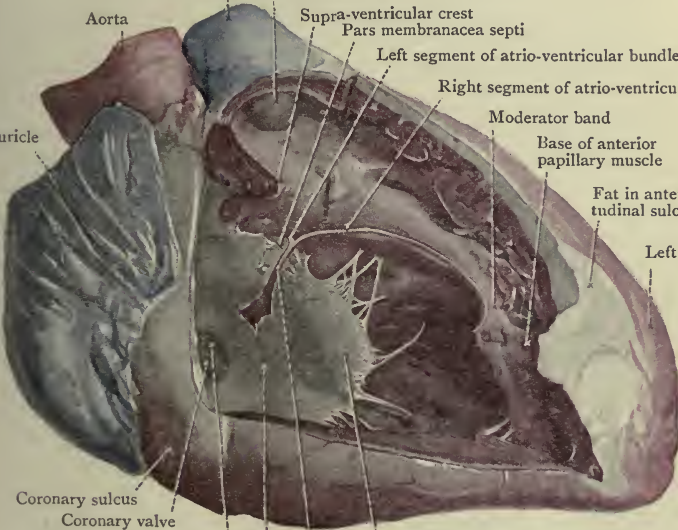


FIG. 51.—Dissection of the Right Ventricle showing the Atrio-ventricular Bundle.

and left branches. The right branch runs along the right side of the septum to the moderator band, along which it passes to the anterior papillary muscle. The left branch passes between the membranous part and the upper end of the muscular part of the septum, and then descends along the left side of the septum. Both branches send off numerous ramifications which are distributed to the various parts of the walls of the ventricles. It is only occasionally that the atrio-ventricular bundle can be displayed in the heart of an ordinary dissecting-room subject.

The *pulmonary orifice* lies at the upper, posterior, and left part of the ventricle, at the apex of the conus arteriosus. Its centre is behind the third left costal cartilage immediately to the left of the left border of the sternum, and its margin is surrounded by a thin fibrous ring to which the bases of the three semilunar cusps of the pulmonary valve are attached.

Dissection.—Note that immediately above its commencement the wall of the pulmonary artery shows three distinct bulgings; they are the pulmonary sinuses (Valsalva), of which two are anterior, and the third is situated posteriorly. Make a transverse incision across the wall of the pulmonary artery immediately above the dilatations, and from each end of the transverse incision make a vertical incision upwards towards the arch of the aorta; raise the flap so formed and examine the cusps of the valve from above.

The Pulmonary Valve.—Each cusp of the valve is of semilunar form. Its upper or arterial surface is concave, its lower or ventricular surface is convex; and it consists of a layer of fibrous tissue covered, on each surface, with a layer of endothelium. The fibrous basis of the cusp is not equally thick in all parts. A stronger band runs round both the free and the attached margin. The centre of the free margin is thickened to form a small rounded mass—the *nodulus of the valve*—and the small thin semilunar regions on each side of the nodule are called the *lunulæ of the valve.* When the ventricular contraction ceases, and the elastic reaction of the wall of the pulmonary artery forces the blood backwards towards the ventricle, the cusps of the valve are forced into apposition; the nodules meet in the centre of the lumen; the ventricular surfaces of the lunulæ of adjacent cusps are compressed against each other, and their free margins project upwards into the cavity of the artery, in the form of three vertical ridges which radiate from the nodules to the wall of the artery. Regurgitation of blood into the ventricle is thus prevented.

The dissector may readily demonstrate the general appearance of the cusps and their relationship to each other by packing the concavity of each cusp with cotton wool.

Arteria Pulmonalis.—The stem of the pulmonary artery is about 50 mm. (two inches) long. It lies within the fibrous pericardium, enclosed, with the ascending part of the aorta, in a common sheath of the serous pericardium. It commences at the upper end of the conus arteriosus, posterior to the sternal extremity of the third left costal cartilage; and it runs, backwards and upwards, into the concavity of the aortic arch, where it bifurcates into two branches, the right and left pulmonary arteries. The bifurcation takes place posterior to the sternal end of the second left costal cartilage.

Relations.—At its commencement it is placed anterior to the lower end of the ascending aorta, but as it runs backwards and upwards it passes to the left side of the aorta, and lies in front of the upper part of the anterior wall of the left atrium, from which it is separated by the transverse sinus of the pericardium. Anterior to it is the upper part of the anterior wall of the pericardium, which separates it from the anterior part of the mediastinal surface of the left pleura and lung. To its right side are the right coronary artery and the apex of the auricle of the right atrium, below, and the ascending aorta, above. To its left side lie the left coronary artery and the anterior end of the auricle of the left atrium.

***Dissection.*—Cut away the anterior wall of the pulmonary artery up to the level of its bifurcation and pass probes into its right and left branches. Note that the right branch runs nearly transversely to the right, and that the left branch runs backwards and to the left.**

The *right pulmonary artery* commences at the bifurcation of the pulmonary stem, below the arch of the aorta. It at once runs to the right, towards the hilum of the right lung, along the upper border of the left atrium and the transverse sinus of the pericardium (Figs. 28, 37, 59). It passes behind the ascending aorta and the superior vena cava, and in front of the œsophagus and the stem of the right bronchus. It enters the hilum of the lung below the eparterial branch of the bronchus, above and posterior to the upper right pulmonary vein; and it descends, in the substance of the lung, on the postero-lateral side of the stem bronchus, and between its ventral and its dorsal branches, where it has already been dissected (p. 59).

Branches.—As it enters the hilum of the lung it gives off a branch which accompanies the eparterial bronchus, and as it descends in the substance of the lung it gives off branches which correspond with the branches of the stem bronchus (see p. 62).

The *left pulmonary artery* runs to the left and slightly backwards, across the anterior aspect of the descending aorta and the left bronchus, to the hilum of the left lung (Figs. 20, 25). It is covered anteriorly and on the left by the anterior part of the mediastinal surface of the left pleural sac. As it descends in the substance of the lung it lies along the postero-lateral aspect of the stem bronchus and between its ventral and dorsal branches (p. 62).

Branches.—The branches of the left pulmonary artery are similar to those given off by the right pulmonary artery, except that it has no branch corresponding with that which accompanies the eparterial bronchus on the right side.

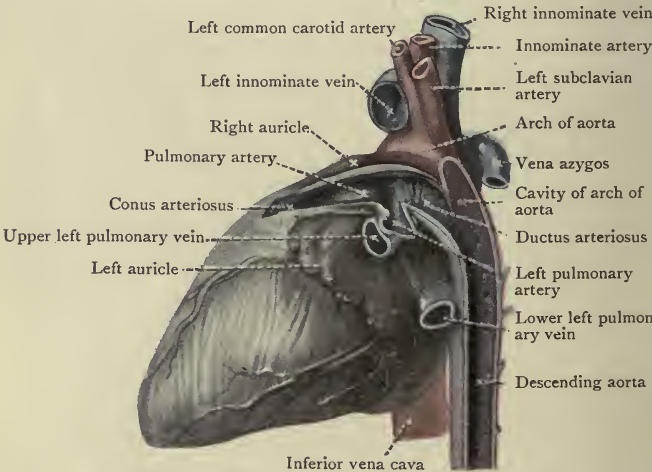


FIG. 52.—Dissection of the Heart and Great Vessels of a Fœtus, showing the angular junction of the Ductus Arteriosus with the Aorta.

Ligamentum Arteriosum.—The ligamentum arteriosum has already been displayed. It is a fairly strong fibrous band which connects the commencement of the left pulmonary artery with the lower surface of the arch of the aorta. In the adult it has no particular importance, and its interest lies in the fact that it is the remains of the walls of a wide channel, the *ductus arteriosus* (Fig. 52), which united the left pulmonary artery with the aorta throughout pre-natal life.

During fœtal life the lungs had no aerating function; therefore the right pulmonary artery and the part of the left pulmonary artery beyond the origin of the ductus arteriosus were small, for they had merely to convey sufficient blood to maintain the life and growth of the non-functional lungs. At that period, therefore, the blood which had entered the right ventricle, through the superior vena cava and the right atrium (see p. 92), was ejected, by the ventricle, into the pulmonary artery, and the greater part of it passed through the ductus arteriosus into the aorta, which it entered beyond the origin of the left subclavian artery, and there mingled with the more oxygenated blood from the placenta, the lower part of the trunk, and the lower limbs, which passed from the inferior vena cava, through the right atrium and the foramen ovale, to the left atrium, and thence to the left ventricle, by which it was pumped into the aorta.

It is obvious that the passage of blood from the pulmonary artery into the aorta could take place only so long as the pressure in the pulmonary artery was greater than the pressure in the aorta. At birth, when the blood rushes through the rapidly enlarged right and left pulmonary arteries into the lungs, as they expand with the first respiratory efforts, the pressure in the pulmonary artery and the ductus arteriosus is reduced below that in the aorta, and blood would flow, from the aorta, through the ductus arteriosus into the pulmonary artery were it not that an alteration of the position of the heart, caused by the expansion of the lungs, produces a twisting of the arterial duct which results in the obliteration of its channel. After blood ceases to flow through it the duct rapidly contracts, and is ultimately reduced to the condition of a fibrous ligament. In a few cases the duct remains open and then peculiar physical signs are produced with which the student will become acquainted during the course of his medical work.

Note that the left recurrent nerve curves round the lower surface of the aortic arch on the left side of the upper end of the ligamentum arteriosum, and that the superficial cardiac plexus lies below the aortic arch immediately to the right of the ligament.

Dissection.—Cut through the remains of the upper part of the conus arteriosus immediately below the bases of the cusps of the pulmonary valve, and carefully dissect the upper part of the conus and the lower part of the pulmonary artery away from the front of the commencement of the ascending aorta. When that has been done, turn the lower end of the pulmonary artery upwards and pin it to the arch of the aorta (see Fig. 53). The upper part of the anterior wall of the left ventricle and the commencement of the aorta are now exposed, and the dissector should note three bulgings at the commencement of the aorta—the three aortic sinuses. One of the three sinuses lies anteriorly, and the right coronary artery springs from it (Fig. 45). The other two, a right and a left, lie posteriorly, and the left coronary artery springs from the left sinus.

Make a transverse incision across the upper end of the left ventricle, a short distance below the base of the anterior aortic sinus. On the right side extend the incision into the upper part of the interventricular septum and carry it downwards, cutting through the anterior part of the septum as far as the apex of the heart. From the left extremity of the upper transverse incision carry an incision downwards and forwards through the left lateral border of the anterior surface of the left ventricle, parallel with the incision already made in the septum, towards the apex. As this incision is made, pull the anterior wall of the left ventricle forwards till the base of a large papillary muscle which springs from its internal surface is exposed; carry the incision anterior to that muscle and then onwards to the apex, and remove the anterior wall of the left ventricle and the anterior part of the inter-ventricular septum. The cavity of the left ventricle and the mitral valve, which guards the left atrio-ventricular orifice, are now exposed (Fig. 53).

Ventriculus Sinister.—The cavity of the left ventricle is longer and narrower than that of the right ventricle. It reaches to the apex, and when exposed from the front it appears to be of conical shape. In cross section it has a circular or broadly oval outline, and its walls are very much thicker than those of the right ventricle (Fig. 50). When the interior has been cleaned with the aid of a sponge and forceps, the dissector will note that its walls are covered with a dense mesh-work of *trabeculæ carneæ*, which are finer and much more numerous than those met with in the right ventricle. The network is especially complicated at the apex and on the inferior wall of the ventricle, whilst the surface of the septum and the upper part of the anterior wall are, comparatively speaking, smooth. But whilst the trabeculæ carneæ in the left ventricle are slighter and more numerous than those in the right, the *musculi papillares*, on the other hand, are less numerous and much stronger; indeed, as a general rule there are only two papillary muscles in the left ventricle, an anterior and an inferior, the former attached to the anterior wall and the latter to the inferior wall of the cavity. The *chordæ tendineæ* from the papillary muscles pass to the margins and to the ventricular surfaces of the two cusps of the mitral valve, which guards the left atrio-ventricular orifice, the chordæ tendineæ from each papillary muscle gaining attachment to the adjacent margins of both cusps.

Dissection.—Detach the anterior papillary muscle from the anterior wall of the ventricle and note that its chordæ tendineæ go to the anterior and left margins of the cusps of the mitral valve. Introduce the blade of a scalpel between the anterior margins of the cusps and carry it downwards between the groups of chordæ going to the apex of the papillary muscle; then split the papillary muscle from its apex to its base, leaving each half connected with a corresponding group of chordæ tendineæ. The cusps of the mitral valve can now be separated from each other, and the atrio-ventricular orifice and the cavity of the ventricle can be more completely examined.

The Orifices of the Left Ventricle.—There are two orifices of the left ventricle—one of entrance, the left atrio-ventricular orifice, and one of exit, the aortic orifice.

The Left Atrio-ventricular Orifice.—The left atrio-ventricular orifice lies in the lower and posterior part of the ventricle, posterior to the left margin of the sternum, at the level of the fourth left costal cartilage. It is somewhat smaller than the right atrio-ventricular orifice and admits the tips of two fingers only, a fact which will be better appreciated when the orifice is examined from the left atrium, at a later period. It is guarded by a valve, formed by two cusps and called, therefore, the *bicuspid valve*, which prevents regurgitation of blood from the left ventricle into the left atrium.

Valvula Bicuspidalis.—The bicuspid, mitral or left atrio-ventricular valve consists of two cusps, a large superior (anterior) and a small inferior (posterior). Occasionally, however, as on the right side, small additional cusps are interposed between the bases of the main cusps. The bases of the cusps are attached to a fibrous ring which surrounds the atrio-ventricular orifice, and their apices project into the cavity of the ventricle. To their apices, margins and ventricular surfaces are attached the chordæ tendineæ from the papillary muscles, which hold the margins of the cusps together and prevent the valve being driven backwards into the atrium during the contraction of the ventricle. The dissector should note, however, that the chordæ tendineæ spread less over the ventricular surface of the superior cusp than over that of the inferior cusp, and he should associate this fact with the circumstance that blood flows over both surfaces of the large superior cusp, which intervenes between the atrio-ventricular and the aortic orifices. By means of the large superior cusp of the mitral valve the cavity of the ventricle, which has, on the whole, a somewhat conical form, is converted into a bent U-shaped tube, one limb of the tube lying below and to the left, and the other anteriorly and to the right. The blood enters the ventricle below and posteriorly through the atrio-ventricular orifice. It runs forwards towards the apex of the cavity along the inferior surface of the superior cusp of the mitral valve, then, as the ventricle contracts, it is driven upwards, backwards, and to the right, to the aortic orifice, along the anterior surface of the large anterior cusp of the mitral valve. The portion of the cavity of the left ventricle which lies directly below the aortic orifice is known as the *aortic vestibule* (Fig. 53). Its walls consist mainly of fibrous tissue;

therefore they remain quiescent during the contraction of the ventricle and, as a result, the rapid closure of the aortic valve is not interfered with when the ventricular contraction ceases and the elastic reaction of the walls of the aorta tends to force blood back into the ventricle.

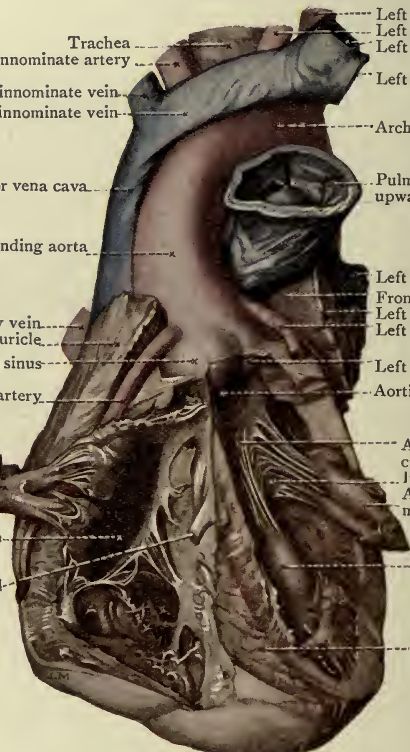


FIG. 53.—Dissection of the Heart from the anterior aspect.

The *aortic orifice* lies at the upper, right, and posterior part of the cavity, posterior to the left margin of the sternum, at the level of the third intercostal space. Its left and inferior margin is separated from the atrio-ventricular orifice by the superior cusp of the mitral valve. It is guarded by a valve, *the aortic valve*, which prevents regurgitation from the aorta into the ventricle. The aortic valve, like the pulmonary

FIG. 54.—Transverse section through the Thorax of a young Male Adult along the plane **D-D**, Fig. 15.

1. Sternum.
2. Papillary muscle of right ventricle.
3. Fifth costal cartilage.
4. Pectoralis major.
5. Skin.
6. Right coronary artery.
7. Cavity of right pleura.
8. Musculi pectinati.
9. Pericardium.
10. Cavity of right atrium.
11. Opening of hepatic vein.
12. Valve of inferior vena cava.
13. Inferior vena cava.
14. Right phrenic nerve.
15. Left atrium.
16. Right bronchus.
17. Lower right pulmonary vein.
18. Œsophagus.
19. Vena azygos.
20. Accessory hemiazygos vein.
21. Cavity of left pleura.
22. Eighth rib.
23. Intervertebral cartilage between seventh and eighth thoracic vertebræ.
24. Thoracic duct.
25. Descending aorta.
26. Left bronchus.
27. Lower left pulmonary vein.
28. Oblique sinus of pericardium.
29. Coronary sinus.
30. Left atrio-ventricular orifice.
31. Left phrenic nerve.
32. Inferior papillary muscle of left ventricle.
33. Anterior margin of left pleura.
34. Septal cusp of tricuspid valve.

valve, consists of three semilunar cusps, but, in contradistinction to the pulmonary valve, one of the cusps is placed anteriorly and the other two posteriorly. The cusps of the aortic valve are stronger than the cusps of the pulmonary valve described on p. 102, but correspond with them in all details of structure.

Before terminating his examination of the left ventricle the dissector should note that the muscular wall of the cavity is thickest a short distance from the atrio-ventricular orifice and thinnest at the apex; and he should examine the interventricular septum.

Septum Ventriculorum.—The interventricular septum is a musculo-membranous partition which separates the left ventricle not only from the right ventricle, but also from the lower part of the right atrium. In the greater part of its extent the septum is thick and muscular—*septum musculare ventriculorum*—but its upper and posterior part which is connected with the fibrous rings round the atrio-ventricular orifices, and the orifices of the pulmonary artery and the aorta, is membranous—*septum membranaceum ventriculorum* (Fig. 55). The muscular part of the septum is thickest below and anteriorly, where it springs from the lower border of the heart immediately to the right of the apex and opposite the cardiac notch, but it becomes gradually thinner as it passes upwards and backwards to its union with the membranous part. The membranous portion is the thinnest part of the septum. Occasionally it is deficient in whole or in part, and in such cases a communication exists between the two ventricles, and, in some rare cases, between the left ventricle and the right atrium.

The membranous part of the septum was exposed, from the right side, when the anterior part of the medial cusp of the tricuspid valve was removed if the dissection of the atrio-ventricular bundle was attempted (see p. 101).

Finally, the dissector should note that the interventricular septum is placed obliquely, so that its anterior border lies to the left and its inferior border to the right; and that its right lateral surface, which looks forwards and to the right, bulges towards the cavity of the right ventricle (Fig. 50).

The Aorta.—The aorta is the great arterial trunk of the body. It commences from the upper, posterior and right portion of the left ventricle, at the level of the third intercostal spaces and posterior to the left margin of the sternum. It terminates at the level of the lower part of the fourth lumbar vertebra, to the left of the median plane, where it divides into the right and left common iliac arteries. It is described as consisting of three main parts: (1) the ascend-

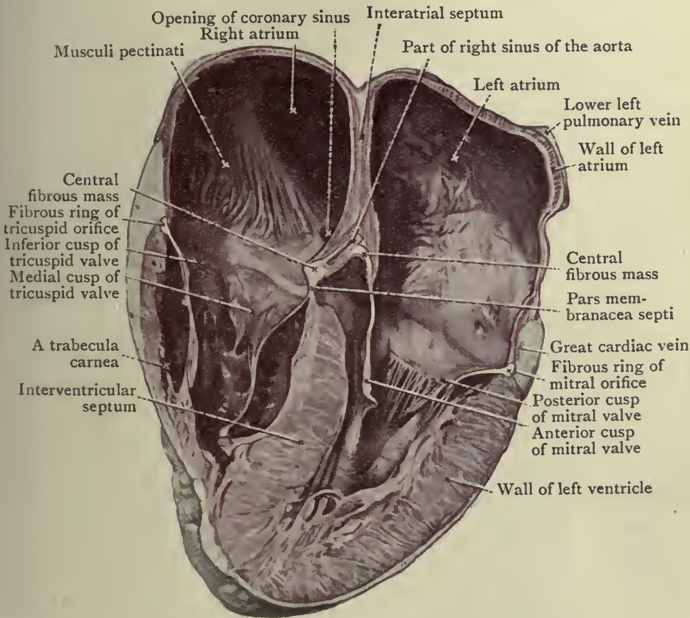


FIG. 55.—Section of the Heart showing the Interventricular and Interatrial Septa and the Fibrous Rings round the Orifices.

ing part, (2) the arch, and (3) the descending part. The descending part is divided into (*a*) thoracic and (*b*) abdominal portions. The first two parts and the thoracic portion of the third part are met with in the dissection of the thorax.

The Ascending Part of the Aorta.—The ascending aorta (Figs. 20, 28, 53, 56) commences at the aortic orifice of the left ventricle and runs upwards, to the right and slightly forwards, posterior to the first piece of the body of the sternum, to the level of the sternal end of the second right costal cartilage, where it becomes the arch of the aorta. It lies in the middle mediastinum, is enclosed in the fibrous sac of the pericardium, and is ensheathed by a covering of the serous sac which is common to it and the stem of the pulmonary artery. The lumen of the ascending portion of the aorta is not of uniform diameter; on the contrary, it presents four dilatations, three at the commence-

FIG. 56.—Transverse section through the Mediastinum at the level of the fifth thoracic vertebra.

ment, the *aortic sinuses* (Valsalvæ), and one along the right border, the *great sinus of the aorta.* The latter is merely an ill-defined bulging along the right border of the vessel.

Relations.—The lower part of the ascending aorta lies posterior to the upper part of the conus arteriosus and the lower part of the stem of the pulmonary artery; but the upper part is in direct relation with the anterior wall of the pericardium, which separates it from the anterior part of the mediastinal surface of the right pleura and lung. Posterior to the ascending aorta, from below upwards, are both atria, the right pulmonary artery and the right bronchus. To the right are the auricle of the right atrium, below, and the superior vena cava, above; and to the left lie the left auricle, below, and the upper part of the stem of the pulmonary artery, above.

Branches.—Only two branches are given off from the ascending part of the aorta; they are the right and left coronary arteries. The right springs from the anterior aortic sinus and the left from the left posterior sinus. Their distribution has been described already (p. 84).

The Arch of the Aorta.—The aortic arch commences at the termination of the ascending part of the aorta, at the level of the second costal cartilage, and posterior to the right margin of the sternum, from which it is separated by the anterior part of the mediastinal portion of the right pleura and lung, or by the remains of the thymus (Figs. 46, 57). It runs backwards, to the left, and slightly upwards, through the middle mediastinum and round the left margins of the trachea and œsophagus (see Figs. 23 and 57), to the level of the lower border of the left side of the fourth thoracic vertebra, where it becomes continuous with the descending part of the aorta. It is curved in both the vertical and the horizontal planes, and as it passes backwards and to the left it forms a convexity upwards, and also a convexity which is directed forwards and to the left. Its lower border is connected with the left pulmonary artery by the ligamentum arteriosum, and from its upper border arise the three great vessels which supply the head, neck and superior extremities (Figs. 32, 39).

Relations.—*Above*, the left innominate vein runs along its upper border, immediately anterior to the inferior parts of the innominate artery, the left common carotid artery and the left subclavian artery, which spring from it; the innominate artery arises from the apex of the convexity of the arch, posterior and a little to the left of the centre of the manubrium sterni; the left common carotid artery arises close to, and sometimes in common with, the innominate artery, whilst the origin of the left subclavian artery is a little more posterior and to the left, separated by a distinct interval from the left common carotid (Fig. 32).

Below the arch lie—(1) the bifurcation of the stem of the pulmonary artery and portions of its right and left branches; (2) the ligamentum arteriosum, which connects the commencement of the left pulmonary artery with the arch; (3) the superficial part of the cardiac plexus, immediately to the right of the ligamentum arteriosum; (4) the left recurrent

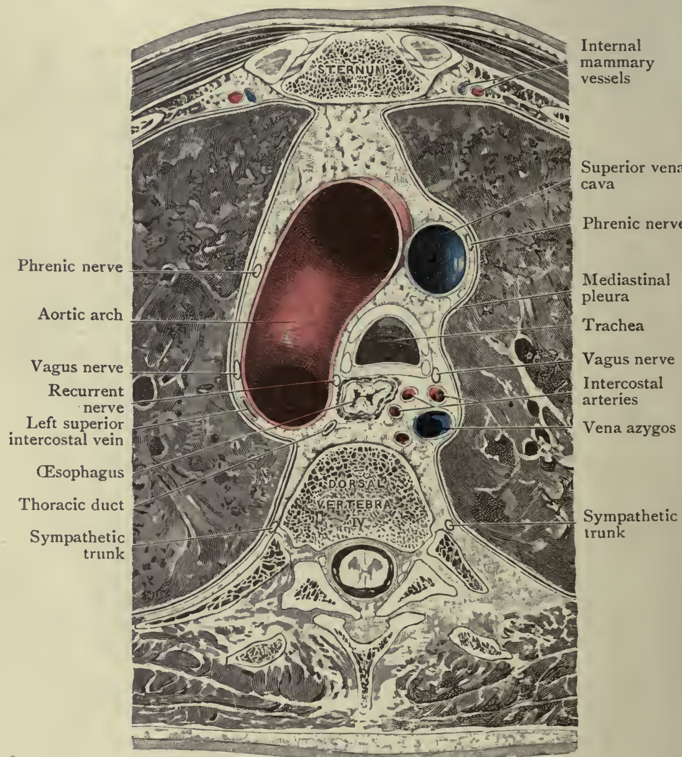


FIG. 57.—Transverse section through the Superior Mediastinum at the level of the fourth thoracic vertebra.

nerve, on the left side of the ligament; and (5) still further to the left, the left bronchus passes beneath the arch on its way to the hilum of the left lung. *To the right* of the arch and somewhat behind it are the trachea, the œsophagus, the left recurrent nerve, and the thoracic duct. The nerve lies in the angle between the œsophagus and the trachea, and the thoracic duct is posterior to, and to the left of, the œsophagus (Fig. 57). The left side of the arch, which is curved so that it is directed forwards as well as to the left, is related to the mediastinal surface of the left pleura and lung, but intervening between the pleura and the arch are—(1) the remains of the thymus gland, (2) the left phrenic nerve, (3) the inferior cervical cardiac branch of the left vagus, (4) the superior cervical cardiac branch of the left sympathetic, (5) the left vagus, and (6) the left superior intercostal vein. The vein passes upwards and forwards, lying to the left of the vagus and the cardiac nerves, and to the right of the phrenic nerve (Figs. 47, 57).

Dissection.—Divide the right coronary artery close to its origin. Cut through the anterior wall of the ascending part of the aorta on each side of the anterior aortic sinus; extend the incisions upwards to the commencement of the aortic arch, and examine the aortic valve. Note that it is formed by three semilunar cusps which are much stronger than the semilunar cusps of the pulmonary valve (p. 102), but are exactly similar in structure and attachments. Note further that one cusp lies anteriorly, and the other two posteriorly. Examine the aortic sinuses and note that the right coronary artery springs from the anterior sinus, and the left coronary from the left posterior sinus. Note further that the orifices of the coronary arteries, as a rule, lie immediately above the level of the upper margins of the semilunar cusps. Replace the stem of the pulmonary artery in position, and note the relative positions of the pulmonary, aortic, and atrio-ventricular orifices.

Topography of the Great Orifices of the Heart.—Replace the sternum in position and note the relations of the cardiac orifices to the bone. The pulmonary orifice is highest. It lies to the left of the margin of the sternum at the level of the third costal cartilage. The aortic orifice is a little lower, and more to the right, posterior to the left margin of the sternum, at the level of the third left intercostal space. Below the aortic orifice is the left atrio-ventricular orifice, posterior to the left margin of the sternum at the level of the left fourth costal cartilage. Still lower and more to the right is the right atrio-ventricular orifice, posterior to the centre of the sternum at the level of the fourth intercostal spaces (Fig. 58).

Dissection.—Divide the phrenic nerves immediately above the diaphragm; then, with the handle and the edge of the scalpel, detach the lower part of the pericardium from the diaphragm. The attachment of the pericardium to the muscular part of the diaphragm is not close, and can easily be broken down. The attachment to the central tendon is much more firm and, as the median plane is approached, the aid of the edge of the knife will probably be necessary before a separation can be effected. Divide the right innominate vein and the right phrenic nerve, immediately above the upper end of the superior vena cava, and as the division is made take care not to injure the right vagus, posterior to the vein. Then divide the vena azygos just posterior to its entrance into the superior vena cava. Cut the inferior thyreoid veins, the innominate artery and the left common carotid artery, immediately above the upper border of the left innominate vein, and then if the left innominate vein has not already been divided, divide it in the interval between the left common carotid and the left subclavian arteries. Cut the left phrenic nerve, the superior cervical cardiac branch of the left sympathetic trunk, and the inferior cervical cardiac branch of the left vagus, immediately above the upper border of the aortic arch.

Next divide the aortic arch. Enter the knife at the upper border of the arch, between the left common carotid and left subclavian arteries and anterior to the left vagus and the left recurrent nerve, and cut from above downwards, completing the division of the arch at the lower border, immediately to the left of the upper end of the ligamentum arteriosum. The left superior intercostal vein will be divided at the same time, but care must be taken not to injure the left recurrent nerve, which is curving round the arch from the front to the back. When the incisions are completed, pull forwards the anterior part of the aortic arch, with the superior vena cava and the lower parts of the innominate veins, and separate them from the lower part of the trachea and from the bronchi. As the separation proceeds, keep the edge of the knife turned towards the aortic arch, to avoid injury to the deep part of the cardiac plexus, which lies anterior to the bifurcation of the trachea. When the lower border of the arch is reached, the twigs which connect the superficial with the right half of the deep part of the cardiac plexus will be exposed, and must be divided. When that has been done, detach the posterior surface of the pericardium from the front of the œsophagus and the descending aorta, taking care to avoid injury to the plexus formed by the vagi nerves on the anterior aspect of the œsophagus. As soon as the separation is completed, the heart, with the remains of the pericardium and the lower parts of the phrenic nerves, can be removed from the thorax, and the investigation of the left atrium and the structure of the heart can be proceeded with ; but, before that is done, the dissector should note that the posterior wall of the pericardium intervenes between the posterior wall of the left atrium and the anterior surfaces of the œsophagus and the descending part of the aorta, opposite the middle four thoracic vertebræ (Fig. 28).

After the heart and the roots of the great vessels have been removed from the thorax, fasten the left vagus and the recurrent nerve to the part of the arch left *in situ* by one or two points of suture ; then cut away the remains of the pericardium from the heart, leaving only those portions of it which mark the lines of reflection of the parietal to the visceral portions of the serous sac. Note, as the posterior wall of the pericardium is removed, that it forms the posterior boundary of the oblique sinus (p. 81).

Atrium Sinistrum.—The left atrium, like the right, is separable into two parts—a larger main portion, the atrium proper or body; and a long narrow prolongation, the auricle (O.T. auricular appendage), which runs from the left margin of the body forwards and to the right. The four pulmonary

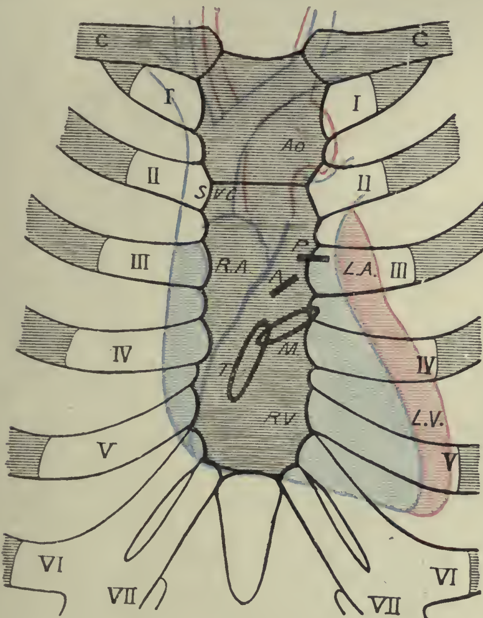


FIG. 58.—The relations of the Heart and of its Orifices to the Anterior Thoracic Wall.

I to VII. Costal cartilages.
A. Aortic orifice.
Ao. Arch of Aorta.
C. Clavicle.
LA. Left atrium.
LV. Left ventricle.
M. Mitral orifice.
P. Pulmonary orifice.
RA. Right atrium.
RV. Right ventricle.
SVC. Superior vena cava.
T. Tricuspid orifice.

veins, two on each side, open into the left atrium. They enter close to the upper ends of the lateral borders of the posterior surface, and not uncommonly the right or the left pair may fuse into a common trunk at the point of entrance.

It has been noted previously that the left atrium forms the greater part of the base of the heart, a small part of the anterior or sterno-costal surface, and a still smaller part of the left border. The only part which can be seen from the front, when the heart and great arteries are *in situ*, is the apical portion of the auricle (appendage), for the portion which enters into the formation of the sterno-costal surface is hidden by the roots of the aorta and the pulmonary artery (Fig. 39).

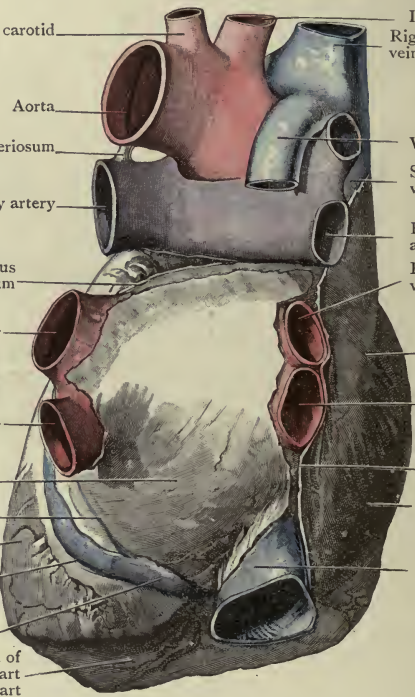


FIG. 59.—Posterior or Basal Aspect of a Heart hardened *in situ* by formalin injection.

The posterior wall of the left atrium is of quadrangular outline. Along its superior border lie the right and left pulmonary arteries. It is bounded inferiorly by the posterior part of the coronary sulcus, in which lies the coronary sinus, and on the right by an indistinct *interatrial sulcus*, which indicates the position of the posterior border of the interatrial septum. Descending obliquely across the posterior wall of the left atrium, from the lower border of the left inferior pulmonary vein, downwards and to the right to the coronary sinus, is the oblique vein (Marshalli), which is the remains of the left duct of Cuvier of the fœtus. Occasionally it becomes the lower end of a left superior vena cava.

Dissection.—Open the left atrium by three incisions—one horizontal and two vertical. The horizontal incision must run from side to side along the lower border of the atrium, immediately above the coronary sulcus ; and the vertical incisions must ascend from the extremities of the horizontal incision to the

FIG. 60.—The Left Atrium opened from behind. The greater part of the posterior wall has been thrown upwards.

upper border of the posterior surface, each passing to the medial side of the terminations of the corresponding pulmonary veins. When the incisions have been made, the posterior wall of the atrium must be turned upwards whilst the cavity is being examined. From the lower end of the left vertical incision carry the knife forwards, through the lateral wall of the auricle of the left atrium.

The inner surface of the wall of the left atrium is smooth and generally devoid of muscular bundles, but it will be noted that the inner surface of the wall of its auricle (O.T.

auricular appendage) is covered with musculi pectinati. In a formalin hardened heart the dissectors will find a strong muscular ridge which descends from the posterior margin of the commencement of the cavity of the auricle along the left border of the cavity of the atrium anterior to the orifices of the left pulmonary veins, entirely concealing them from view when the cavity is examined from the front.

On the right or septal wall of the left atrium the position of the margin of the valve of the foramen ovale is marked by one or more small semilunar depressions situated between slender muscular ridges. The portion of the septal wall which lies below and posterior to those depressions forms the floor of the fossa ovalis, and is the remains of the valve of the foramen ovale of the fœtus.

The Orifices of the Left Atrium.—The orifices of the left atrium are the openings of the *four pulmonary veins*, the *left atrio-ventricular orifice*, and a number of minute openings which are the mouths of the *venæ cordis minimæ.*

The pulmonary veins convey oxygenated blood from the lungs to the atrium. Through the venæ minimæ cordis a small amount of venous blood, from the walls of the atrium, is passed into its cavity. Through the left atrio-ventricular orifice the blood passes from the left atrium into the left ventricle.

The openings of the pulmonary veins are situated in the posterior wall of the atrium, nearer the upper than the lower part, and close to the lateral borders, two on each side. They are entirely devoid of valves. The orifices of the venæ cordis minimæ, which are scattered irregularly, are also valveless; but the left atrio-ventricular orifice, which lies in the lower part of the anterior wall of the atrium, is guarded by the bicuspid valve, which has been described already (p. 107). The left atrio-ventricular orifice is smaller than the corresponding orifice on the right side, and admits the tips of two fingers only.

The Structure of the Walls of the Heart.—The last step in the dissection of the heart consists in the examination of the structure of its walls. On the outside the walls are covered with the *epicardium*, which is the visceral part of the serous pericardium; and on the inside they are lined with the smooth and glistening *endocardium*, which plays a large part in the formation of the flaps of the valves, and is continuous, through the orifices, with the inner coats of the arteries and veins. Between the epicardium and the endocardium lies the muscular tissue of the heart, which is termed the *myocardium*. The muscular fibres of the myocardium are disposed in layers, in each of which the fibres take a special direction.

The arrangement of the various layers of the myocardium cannot be displayed in an ordinary dissecting-room heart, in which the continuity of the fibres has been destroyed by the incisions made to display the cavities, but the arrangement of the layers is practically the same in the hearts of all mammals. Therefore, for the purpose of studying the layers, the dissectors should obtain a sheep's heart. Fill the heart with a paste made of flour and water; then boil it for a quarter of an hour. The boiling expands the paste, softens the connective tissue, and hardens the muscular fibres. After the boiling is finished the heart should be placed for a time in cold water. After it has cooled, first the epicardium and then the muscular fibres should be gradually torn off.

The atrial fibres are difficult to dissect. They consist of three groups: (1) A superficial group, running more or less transversely and common to both atria. They are best marked near the coronary sulcus. (2) A deep group, special to each atrium. The extremities of the fibres of the deep group are connected with the fibrous atrio-ventricular rings, and they pass over the atria from front to back. (3) The third group consists of sets of annular fibres surrounding the orifices of the veins which open into the atria.

The fibres of the ventricles are more easily dissected. They consist, for the main part, of two groups—the superficial and the deep. The fibres of each set are common to both ventricles, and the dissectors should note the remarkable spiral or whorled arrangement of the superficial fibres which occurs at the apex, where they pass into the deeper parts of the wall.

The superficial fibres spring mainly from the fibrous atrio-ventricular rings. Those which are attached to the right ring turn inwards at the apex and become continuous with the papillary muscles of the left ventricle, whilst the fibres which spring from the left ring pass in the same way to the papillary muscles of the right ventricle. The deeper fibres form an ∽-shaped layer, one loop of the ∽ surrounding the right and the other the left ventricle.

The fibrous rings of the atrio-ventricular orifices intervene between the atrial and the ventricular muscle fibres, but the two groups are brought into association with each other by the atrio-ventricular bundle described on p. 101. It has been assumed that the impulses which regulate the movements of the ventricles were conveyed to them from the atria by the fibres of that bundle, but it has been shown recently that numerous nerve fibrils are intimately intermingled with the fibres of the atrio-ventricular bundle. It is possible, therefore, that the connection between the atria and the ventricles is neuro-muscular.

The Action of the Heart.—The differences between the various parts of the heart, *i.e.* the thinness of the walls of the atria as contrasted with the thickness of the walls of the ventricles, and the greater thickness of the walls of the left as contrasted with those of the right ventricle, are associated with the functions of the various chambers, and with the action which the heart plays in the maintenance of the circulation of the blood. The heart is a muscular pump, provided with receiving and ejecting chambers. It has three phases of action: (1) a period of atrial contraction; (2) a period of ventricular contraction, which immediately succeeds the atrial contraction; (3) a period of diastole or rest.

During the period of diastole or rest the chambers, previously contracted, dilate as the muscular fibres of the heart relax. The dilatation is aided by the respiratory movements of the thorax. As the dilatation progresses blood flows into the right atrium from the superior vena cava, the inferior vena cava and the coronary sinus; and into the left atrium through the four pulmonary veins. The atrial contraction commences with the contraction of the circular fibres which surround the mouths of the veins entering the atria, and thus the blood is prevented from passing back into the veins. As the contraction extends to the general fibres of the atria the blood is forced onwards into the ventricles, which become distended. Then the ventricular contraction commences, the atrio-ventricular valves close, and, as the contraction proceeds, the blood is driven out of the ventricles through the arterial orifices, that in the right ventricle being ejected into the pulmonary artery, and that in the left ventricle into the aorta.

When the ventricular contraction is completed the period of diastole commences; and, as long as the heart remains alive, the cycle is repeated.

The work of the atria is merely to force the blood through the widely open atrio-ventricular orifices into the ventricles and to expand the dilating walls of the ventricles. For that purpose no great force is required, therefore the walls of the atria are thin. The work of the ventricles is much more severe, therefore their walls are thicker. The right ventricle, however, has only to exert sufficient force to drive the blood through the lungs to the left atrium, that is, through a comparatively short distance and against a comparatively small resistance; therefore its walls are thin as compared with the walls of the left ventricle, which have to be sufficiently strong to force the blood through the whole of the trunk, the head and neck, and the upper and lower limbs.

The Topography of the Heart.—Before proceeding to the study of the trachea, the dissectors should replace the heart in position and revise their knowledge of its relations to the surface. Its position can be indicated on the anterior wall of the thorax by the following four lines:—(1) A line commencing at the lower border of the second left costal cartilage, 13 mm. (half an inch) from the left border of the sternum, and ending at the upper border of the third right costal cartilage, about 13 mm. (half an inch) from the right border of the sternum. The line so drawn will indicate the position of the upper border of the heart, which is formed by the upper ends of the atria. (2) A line from the upper border of the third right costal cartilage to the sixth right costal cartilage. That line should commence and end about 13 mm. (half an inch) from the border of the sternum, and should be slightly convex to the right. It indicates the right border of the heart, which is formed by the right atrium alone. (3) A line from the sixth right costal cartilage to the apex, which lies behind the fifth left intercostal space, about 88 mm. (three and a half inches) from the median plane. That line marks the position of the lower border of the sterno-costal surface, which is formed, in the greater part of its extent, by the right ventricle, the left ventricle entering into its constitution only in the region of the apex.

(4) A line from the apex to the lower border of the second left costal cartilage. This line should be convex upwards and to the left; the point of greatest convexity should coincide with the lower border of the fourth left costal arch, and the upper

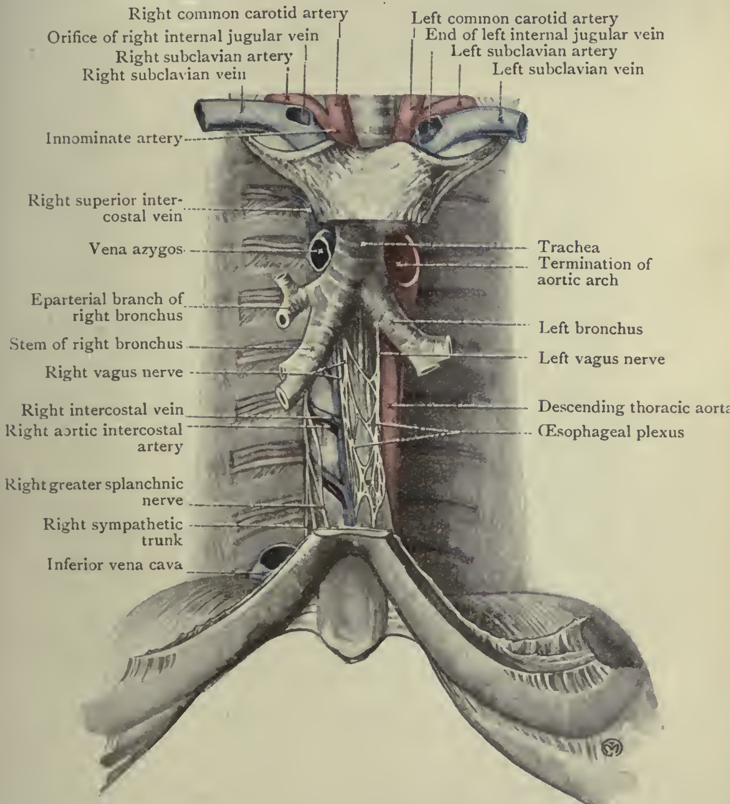


FIG. 61.—Dissection of the Posterior Mediastinum and the posterior part of the Superior Mediastinum, from the anterior aspect.

extremity should be situated about 13 mm. (half an inch) from the left margin of the sternum. It marks the position of the left border of the heart, which is formed in the lower four-fifths of its length by the left ventricle and in the remaining fifth by the left atrium.

A line from the upper border of the sternal end of the third left costal cartilage to the lower border of the sternal end of the sixth right cartilage indicates the anterior part of the coronary sulcus. The points indicating the positions of the arterial and atrio-ventricular orifices must be placed immediately below the line of the coronary sulcus in the following order from above downwards: *pulmonary orifice*, *aortic orifice*, *mitral orifice*, *tricuspid orifice*. The centre of the pulmonary orifice is posterior to the third left costal cartilage

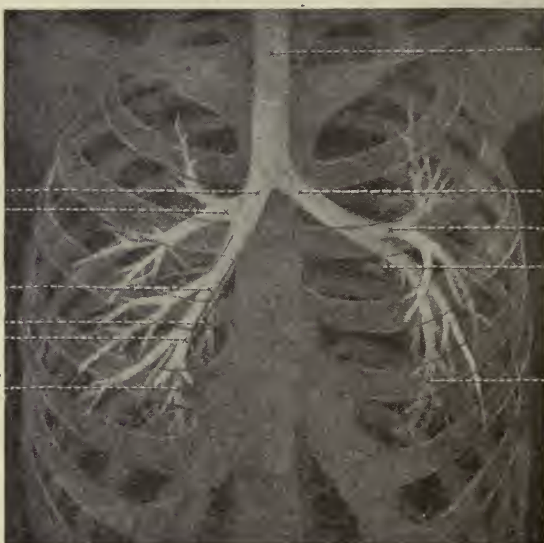


FIG. 62.—Drawing of a Stereoscopic Skiagraph of the Trachea and Bronchi injected with starch and red lead.

at the margin of the sternum. The aortic orifice lies posterior to the left half of the sternum opposite the third intercostal space. The mitral orifice is posterior to the left border of the sternum at the level of the fourth left costal cartilage; and the centre of the tricuspid orifice is posterior to the middle of the sternum at the level of the fourth intercostal spaces.

The Thoracic Portion of the Trachea.—The thoracic portion of the trachea, like the cervical portion, is a wide tube kept constantly patent by a series of curved cartilaginous bars which are embedded in its walls. The bars are deficient posteriorly, and, in consequence, the tube is flattened behind (Fig. 57). It enters the thorax at the upper aperture, posterior to the upper border of the manubrium, and it terminates, at the level of the lower border of the manubrium and the upper border of the fifth thoracic vertebra, by dividing into a right and a left bronchus. It lies, therefore, in the superior mediastinum, and its median axis is in the median plane, except at the lower end, where it deviates slightly to the right.

Relations.—*Posteriorly*, it is in contact with the œsophagus, which separates it from the vertebral column; and in the angle between its left border and the anterior surface of the œsophagus is the left recurrent nerve (Fig. 57).

Anteriorly, it is in relation, below, with the arch of the aorta, the deep part of the cardiac plexus intervening; and, at a higher level, with the innominate and left common carotid arteries, the left innominate vein and the inferior thyreoid veins. More superficially lie the remains of the thymus, and still more superficially the manubrium sterni

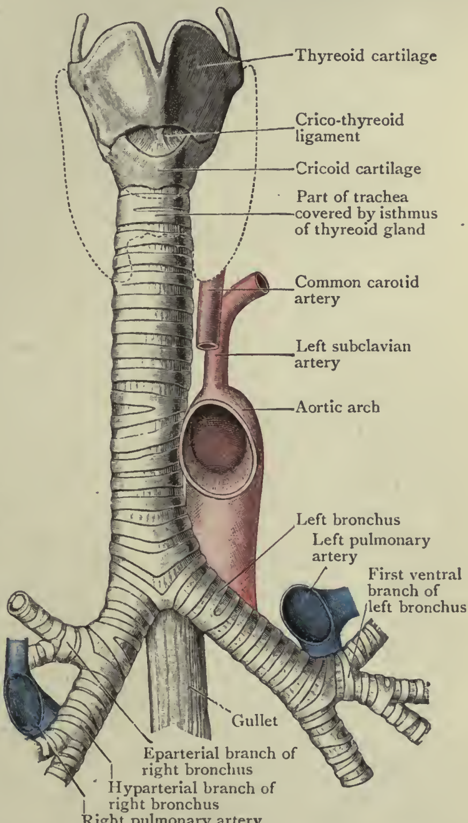


FIG. 63.—The Trachea and Bronchi. The dotted line gives the outline of the thyreoid gland.

with the origins of the sterno-hyoid and sterno-thyreoid muscles, which are attached to it.

On the right, it is in relation with the upper part of the mediastinal surface of the right pleura and lung (Fig. 57), the right vagus nerve, and the arch of the azygos vein (Fig. 13). It is also in relation, on its right side, near its lower end and more anteriorly, with the superior vena cava, and, at a higher level, with the innominate artery.

Its *left relations* are the arch of the aorta, below, and the left subclavian and left common carotid arteries, above.

Bronchi.—Each bronchus passes downwards and laterally, first to the hilum of the corresponding lung, and thence downwards in the substance of the lung to its lower end. It can, therefore, be divided into an extra-pulmonary and an intra-pulmonary portion. The extra-pulmonary part, like the trachea, is kept permanently open by the presence of curved cartilaginous bars in its walls; and as the bars are deficient posteriorly, the extra-pulmonary part of each bronchus presents a flattened posterior surface similar to that of the trachea. The lumina of the intra-pulmonary parts of the bronchi are kept patent by cartilaginous plates which are irregularly distributed in the substance of the walls.

Relations of the Extra-pulmonary Part of the Right Bronchus.—The right bronchus is much more vertical than the left (Fig. 62), and, as the ridge which separates the orifices of the two bronchi at their origins lies to the left of the median line of the trachea, the right bronchus is the more direct continuation of the trachea, and foreign bodies which have entered the windpipe pass more frequently into it than into the left bronchus. It passes downwards and laterally from the upper border of the fifth thoracic vertebra to the level of the upper part of the sixth thoracic vertebra, where it enters the hilum of the right lung. *Anterior to* the extra-pulmonary part of the right bronchus are the ascending part of the aorta, the lower part of the superior vena cava, and the right pulmonary artery. *Above it* is the arch of the azygos vein; and *posterior to it* are the azygos vein, the posterior pulmonary plexus, and the right bronchial artery. The extra-pulmonary part of the right bronchus gives off one branch, which arises close to the hilum and is called the eparterial bronchus, because it originates immediately above

PLATE III

FIG. 64.—Radiograph of Thorax in expiration, showing the positions of the heart, the great vessels and the bronchi.
(Dr. Robert Knox.)

the point where the right pulmonary artery crosses anterior to the stem bronchus.

Relations of the Extra-pulmonary Part of the Left Bronchus.—The extra-pulmonary part of the left bronchus commences and ends at the same level as the corresponding part of the right bronchus, but it has further to go, because the hilum of the left lung is further from the median plane than the hilum of the right lung; therefore, it is longer and less vertical than the right bronchus. It gives off no branches.

Anterior to it are the left pulmonary artery, and the upper and left part of the pericardial sac which separates the bronchus from the left atrium. *Above it* is the arch of the aorta; and *posterior to it* are the descending aorta, the posterior pulmonary plexus, the left bronchial arteries, and the œsophagus.

The intra-pulmonary parts of the bronchi and their relations have already been examined (p. 60). Their positions in relation to the heart are shown in Plate III., Fig. 64.

The Thoracic Portions of the Vagi Nerves.—The thoracic parts of the vagi nerves, which are still in position, should now be examined. Both vagi enter the thorax at the upper aperture.

The right vagus descends, through the superior mediastinum, posterior to the right innominate vein and the superior vena cava, passing obliquely downwards and backwards (Fig. 13) along the side of the trachea, and between the trachea medially, and the right pleura laterally, as far as the arch of the azygos vein. Next, it passes between the trachea medially, and the arch of the azygos vein laterally, and reaches the posterior aspect of the root of the right lung, where it breaks up into a number of branches which unite with branches of the sympathetic trunk to form the posterior pulmonary plexus. It emerges from the plexus usually as a single trunk which runs downwards and medially, in the posterior mediastinum, to the œsophagus. On the œsophagus it breaks up into branches which unite with branches of the left vagus to form the *œsophageal plexus* (Fig. 61). At the lower end of the thorax the right vagus again becomes a single trunk; it passes to the posterior aspect of the œsophagus and enters the abdomen through the œsophageal orifice of the diaphragm.

Thoracic Branches of the Right Vagus.—Whilst the right vagus is in the superior mediastinum it gives off a thoracic cardiac branch, which goes to the right half of the deep cardiac plexus, and some anterior pulmonary branches to the front of the root of the right lung, where they join with branches of the cardiac plexus to form the anterior pulmonary plexus. As it passes posterior to the root of the lung it gives branches to the bronchi and the lung; and in the posterior mediastinum it gives branches to the œsophagus, and to the posterior part of the pericardium and pleura.

The Left Vagus.—As the left vagus descends through the superior mediastinum it lies first behind the left common carotid artery, and behind the left phrenic nerve which crosses from left to right in front of it, and it is in front of the left subclavian artery. Then it passes across the left side of the arch of the aorta. In the latter situation it is crossed laterally by the left superior intercostal vein. Below the lower border of the aortic arch it passes posterior to the root of the left lung, where it breaks up into branches which enter into the formation of the posterior pulmonary plexus. At the lower border of the root of the left lung it emerges from the plexus as two trunks, which descend, into the posterior mediastinum, to the œsophagus, where they unite with branches of the right vagus to form the *œsophageal plexus.* At the lower end of the thorax the left vagus again becomes a single trunk, which passes through the œsophageal orifice of the diaphragm on the anterior aspect of the œsophagus.

Thoracic Branches of the Left Vagus.—In the superior mediastinum, whilst it lies against the left side of the aortic arch, it gives off the left recurrent branch, branches to the upper and anterior part of the pericardium, and branches to the left anterior pulmonary plexus. Posterior to the root of the left lung, it supplies branches to the left bronchus and the left lung; and during its course through the posterior mediastinum, as it takes part in the œsophageal plexus, it gives branches to the œsophagus, to the posterior part of the pericardium, and to the left pleura.

The Thoracic Part of the Left Recurrent Nerve.—The left recurrent nerve springs from the trunk of the left vagus near the lower border of the left side of the aortic arch. It curves round the lower border of the arch, posterior to and to the left of the ligamentum arteriosum, and passes upwards, behind and to the right of the arch, through the superior mediastinum, in the angle between the left border of the trachea and the œsophagus, and posterior to the left common carotid artery. As it turns round the arch it gives branches to the deep cardiac plexus, and, as it ascends along the left border of the trachea, it gives offsets to the trachea and to the œsophagus.

The Deep Cardiac Plexus.—The deep cardiac plexus lies between the arch of the aorta and the bifurcation of the trachea. It is more or less distinctly separable into right and left parts, and the right part is connected with the superficial cardiac plexus. The right part of the plexus receives—(1) three cardiac branches from the cervical part of the right sympathetic trunk; (2) the two cervical cardiac branches of the right vagus; (3) the cardiac branch of the right recurrent nerve; (4) the thoracic cardiac branch of the right vagus. It is connected with the superficial cardiac plexus, and it gives branches to—(1) the right anterior pulmonary plexus; (2) the right atrium; (3) the right coronary plexus. The left part of the deep cardiac plexus receives—(1) the middle and lower cervical cardiac branches of the left sympathetic trunk; (2) the upper cervical cardiac branch of the left vagus; (3) the cardiac branches of the left recurrent nerve. It gives branches to—(1) the left anterior pulmonary plexus; (2) the left atrium; (3) the left coronary plexus.

> ***Dissection.***—Cut through the right and left bronchi, close to their origins from the trachea; then divide the trachea at the upper aperture of the thorax and remove its thoracic portion, but avoid injury to the vagi and the left recurrent nerves. The extra-pulmonary parts of the bronchi will be retained in position by the bronchial arteries and the branches of the pulmonary plexuses; and the thoracic part of the œsophagus will be fully exposed.

The Thoracic Part of the Œsophagus.—The thoracic part of the œsophagus enters the thorax at the upper aperture, passes downwards, through the superior and posterior mediastina, and leaves, at the level of the tenth thoracic vertebra, by passing through the œsophageal orifice of the diaphragm into the epigastric region of the abdomen. As it enters the superior mediastinum it lies somewhat to the left of the median plane, but as it descends it passes medially, gains the median plane at the level of the fifth thoracic vertebra, and continues downwards in that plane to the level of the seventh thoracic vertebra. There it passes forwards and to the left, across the anterior aspect of the descending aorta and posterior to the pericardium (Figs. 65, 66, 68).

Posterior Relations.—*In the superior mediastinum* it is anterior to the left longus colli muscle and the vertebral column. In the upper part of the *posterior mediastinum* it is separated from the vertebral column by—(1) the posterior part of the œsophageal plexus, (2) the upper five right aortic intercostal arteries, (3) the thoracic duct, (4) the vena azygos, (5) the vena hemiazygos and the accessory hemiazygos vein; and in the lower part by (6) the œsophageal plexus and (7) the descending aorta.

Anterior Relations.—Anterior to it, *in the superior mediastinum*, lie the trachea, the left recurrent nerve, the upper part of the left common carotid artery, the left subclavian artery, the arch of the aorta, and the structures which lie still further forwards (pp. 35, 64). *As it passes from the superior to the posterior mediastinum* its anterior relations are first the commencement of the left bronchus and then the right pulmonary artery.[1] *In the posterior mediastinum*, the œsophageal plexus is on its anterior surface, intervening between it and the posterior wall of the pericardium, which separates both the plexus and the œsophagus from the posterior wall of the left atrium; and at a lower level the œsophagus lies posterior to the diaphragm (Fig. 69).

Right Relations.—*In the superior mediastinum*, it is in relation with the right pleura and lung, and with the arch of the vena azygos (Figs. 22 and 13); and, *in the posterior mediastinum*, with the œsophageal plexus and right pleura and lung, until it passes forwards and towards the left, anterior to the descending aorta (Figs. 68, 69).

Left Relations.—*In the superior mediastinum*, it is in relation on the left side with the thoracic duct, the left subclavian artery, the left pleura and lung, and the termination of the arch of the aorta. *From the fifth to the seventh thoracic vertebra* its left lateral relations are the œsophageal plexus and the descending aorta; *its lower part*, which lies in front of the descending aorta, is in relation on the left side with the left pleura and lung.

The dissector should note (1) that, after death, the œsophagus is generally somewhat compressed antero-posteriorly by the structures between which it lies; it probably has a

[1] Verify this statement by replacing the heart *in situ* (see also Figs. 48, 56).

PLATE IV

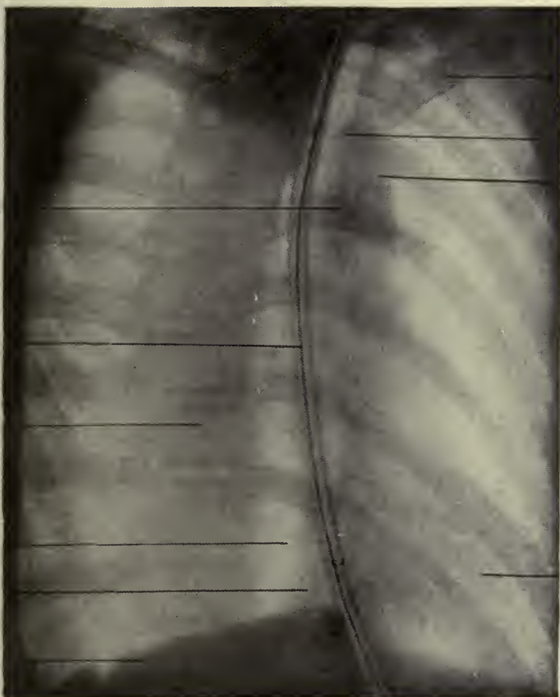


FIG. 65.—Radiograph of Thorax. Oblique view showing the "post-cardiac space."

The "post-cardiac space" lies behind the base of the heart, and more particularly behind the left atrium. The thoracic part of the descending aorta and the œsophagus pass through it. (Goldesbrough.)

PLATE V

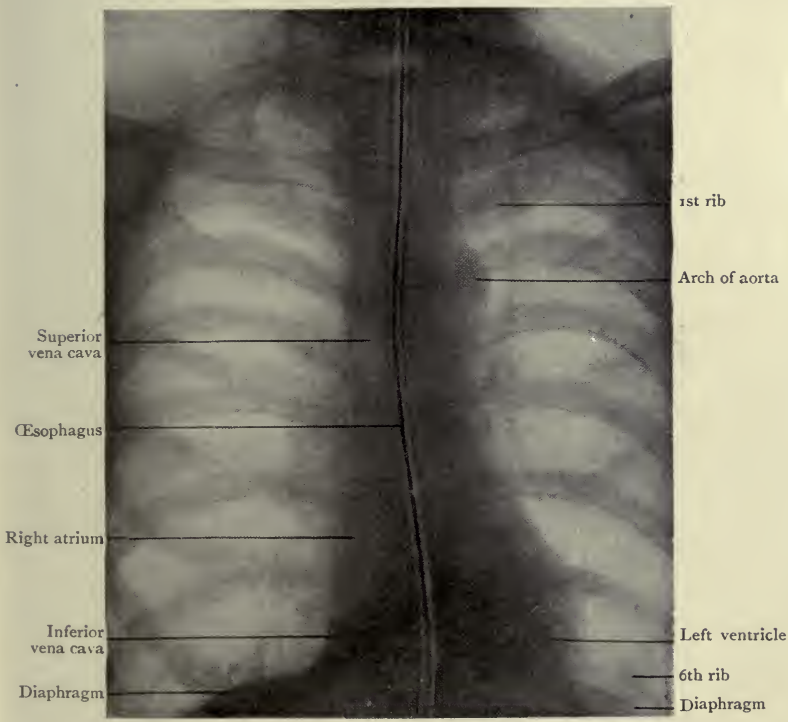


Fig. 66.—Radiograph of the Thorax, showing the position of the Œsophagus into which a bougie with a metal core had been inserted. Anterior view. (Goldesbrough.)

PLATE VI

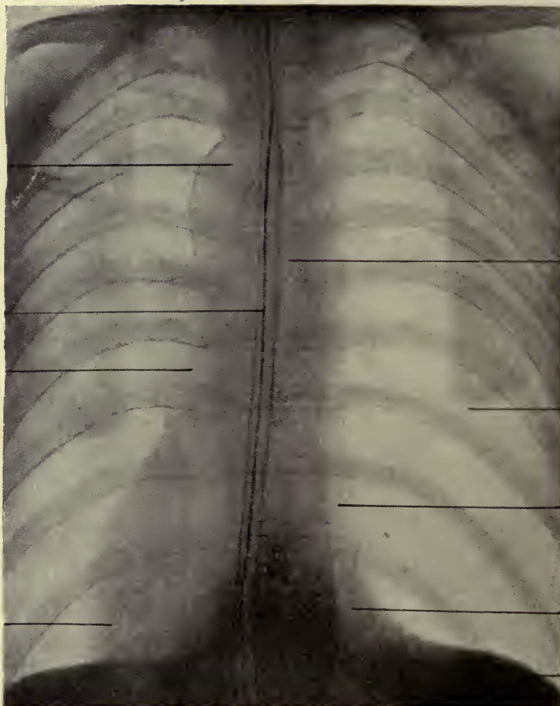


FIG. 67.—Radiograph of Thorax, showing the position of the Œsophagus into which a bougie with a metal core had been inserted. Posterior view. (Goldesbrough.)

similar form during life when empty and flaccid, but becomes more circular when solids or fluids are passing along it;[1] and (2) that it is somewhat constricted at the level of the left bronchus.

An inch or more of the upper part of the posterior mediastinal portion of the tube should be removed and dissected under water in a cork-lined tray. It will be found to possess from without inwards the following coats: (1) an external fibrous sheath; (2) a muscular coat; (3) a submucous coat; and (4) a mucous internal lining. The submucous coat forms a loose connection between the muscular and mucous coats; consequently, when the muscular

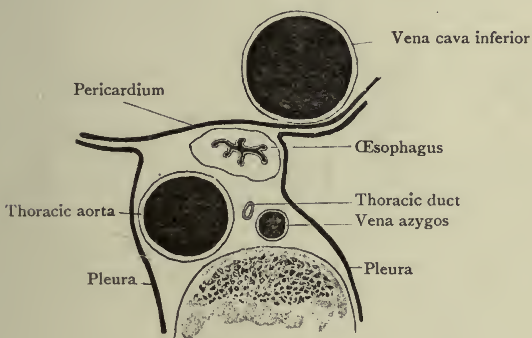


FIG. 68.—Tracing of section through the Posterior Mediastinum at the level of the eighth thoracic vertebra.

coat is contracted the mucous lining is thrown into longitudinal folds. The muscular coat consists of an external layer of longitudinal fibres and an internal layer of circular fibres.

Aorta Descendens.—The descending aorta commences at the termination of the aortic arch, at the lower border of the left side of the fourth thoracic vertebra. It passes downwards, through the posterior mediastinum, and it leaves the thorax by passing through the aortic aperture of the diaphragm, opposite the lower border of the twelfth thoracic vertebra. Its length varies with the length of the thorax but averages from 17·5 to 20 cm. (seven to eight inches). In the upper

[1] It may be dilated after death, see Figs. 47, 48, 54.

part of its extent it lies to the left of the vertebral column; but in the lower part of the thorax it lies anterior to the column, in the median plane (Figs. 56, 54, 47, 48).

Branches.—Branches spring both from the anterior and the posterior aspects of the descending thoracic aorta. Those from the anterior aspect are the two left bronchial arteries, four œsophageal branches, and some small and irregular mediastinal and pericardial branches. The posterior branches are nine pairs of aortic intercostal arteries and one pair of subcostal arteries.

Relations.—*Anterior to* the thoracic part of the descending aorta, from above downwards, are the root of the left lung;

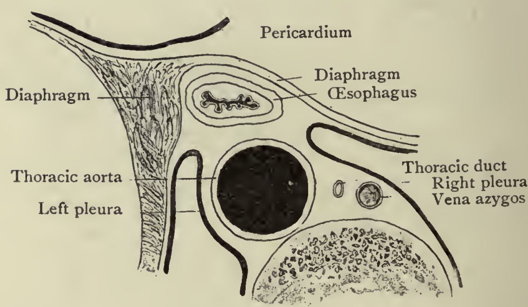


FIG. 69.—Tracing of a section through the lower part of the Posterior Mediastinum, where its anterior wall is formed by the diaphragm.

the upper part of the posterior wall of the pericardium, separating the aorta from the left atrium; the œsophagus, separating the aorta from the lower part of the posterior wall of the pericardium; and the crura of the diaphragm, which separate the lower portion of the thoracic aorta from the omental bursa of the peritoneum and from the posterior surface of the caudate lobe (O.T. Spigelian) of the liver (Fig. 28). *Posteriorly* are the vertebral column, its own intercostal and subcostal branches, the hemiazygos and accessory hemiazygos veins; and it is overlapped posteriorly in the upper part of its extent by the left pleura and lung. *Along its right side*, in its whole length, are the thoracic duct and the vena azygos, and anterior to them, from the fifth to the lower part of the seventh thoracic vertebra, lies the œsophagus. At a lower level a mass of areolar tissue separates the aorta from the

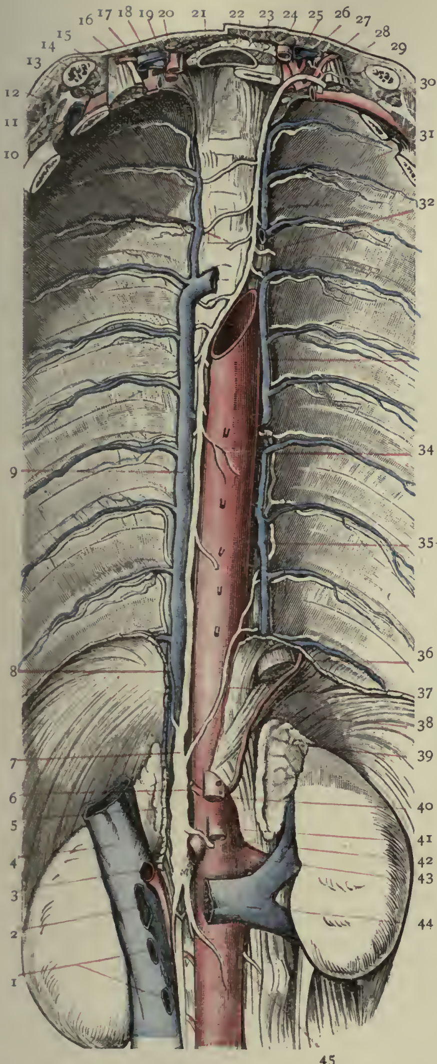


FIG. 70.—The Thoracic Duct and its Tributaries.

1. Lumbar veins.
2. Left renal vein.
3. Right renal artery.
4. Inferior vena cava.
5. Suprarenal gland.
6. Cisterna chyli.
7. Thoracic duct.
8. Descending thoracic lymph trunk.
9. Vena azygos.
10. Mediastinal lymph vessel.
11. Superior intercostal vein.
12. Subclavian vein.
13. Subclavian artery.
14. Clavicle.
15. Scalenus anterior muscle.
16. Phrenic nerve.
17. Thyreo-cervical trunk.
18. Internal jugular vein.
19. Vertebral artery.
20. Common carotid artery.
21. Trachea.
22. Thyreoid gland.
23. Œsophagus.
24. Common carotid artery.
25. Internal jugular vein.
26. Vertebral artery.
27. Thyreo-cervical trunk.
28. Common lymph trunk from head and upper limb.
29. Scalenus anterior muscle.
30. Subclavian artery.
31. Superior intercostal vein.
32. Bronchial lymph vessel.
33. Vena hemiazygos accessoria.
34. Aorta.
35. Vena hemiazygos.
36. Œsophagus.
37. Descending thoracic lymph trunk.
38. Inferior phrenic artery.
39. Suprarenal gland.
40. Cœliac artery.
41. Superior mesenteric artery.
42. Common intestinal lymph trunk.
43. Renal artery.
44. Renal vein.
45. Common lumbar lymph trunk.

right pleura and lung. *On its left side* it is in relation with the left pleura and lung.

Dissection.—Divide the œsophagus at the level of the upper border of the arch of the aorta, and turn the lower part downwards towards the diaphragm. Clean the thoracic duct, the right aortic intercostal arteries, and the hemiazygos and accessory hemiazygos veins, which lie posterior to the œsophagus. Then trace the thoracic duct in the whole of the thoracic portion of its course, and arrange with the dissector of the head and neck to display the cervical portion of its course.

Ductus Thoracicus.—The thoracic duct is a vessel of small calibre but of great importance, for it conveys, to the left innominate vein, the whole of the lymph from the lower extremities, the abdomen (except that from part of the upper portion of the liver), the left side of the thorax (including the left lung and pleura and the left side of the heart), the left upper extremity, and the left side of the head and neck. It is the upward prolongation of a dilated sac—the *cisterna chyli*—which lies between the right crus of the diaphragm and the bodies of the first and second lumbar vertebræ. It enters the thorax through the aortic orifice of the diaphragm, lying between the aorta on the left and the vena azygos on the right. It continues upwards through the posterior mediastinum, lying between the descending aorta and the vena azygos, anterior to the right aortic intercostal arteries and the hemiazygos and accessory hemiazygos veins, and posterior to the right pleura, below, and the œsophagus, above. At the level of the fifth thoracic vertebra it crosses to the left of the median plane, and then ascends, through the superior mediastinum, along the left border of the œsophagus, in contact, on the left, with the left pleural sac, and separated posteriorly from the left longus colli muscle by a quantity of areolar tissue. Anterior to the thoracic duct, in the superior mediastinum, are the termination of the aortic arch, the left subclavian, and the left common carotid arteries, in that order from below upwards. At the upper end of the thorax the thoracic duct enters the root of the neck, and, at the level of the seventh cervical vertebra, it turns laterally, posterior to the left common carotid artery, the left vagus nerve, and the left internal jugular vein, and anterior to the vertebral artery and veins, the thyreo-cervical trunk or inferior thyreoid artery, and the phrenic nerve. Then, turning downwards, forwards and medially, on the anterior aspect of the scalenus anterior, it crosses anterior to the transverse cervical and transverse scapular arteries, and crossing the subclavian artery it terminates in the upper end of the innominate vein, in

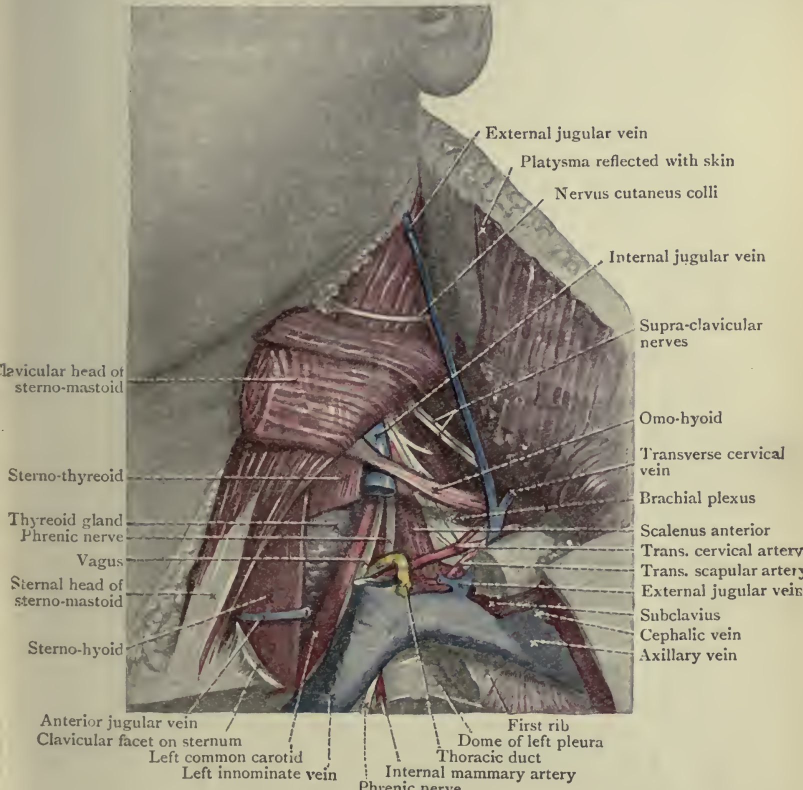


FIG. 71.—Dissection of the Root of the Neck showing the termination of the Thoracic Duct.

the angle of junction of the internal jugular and subclavian veins. Immediately before its termination it receives the left common jugular and subclavian lymphatic trunks, unless they end separately in one or other of the three large veins. When the thoracic duct is distended it has a beaded or nodulated appearance on account of the numerous valves which lie in its interior. The terminal valve is usually situated a short distance from the point of entrance of the duct into the left innominate vein.

The Right Lymph Duct.—From the level of the fifth thoracic vertebra a small lymph vessel, the *broncho-mediastinal lymph trunk*, may be traced upwards along the front of the vertebral column to the root of the neck. At its commencement in the superior mediastinum it not uncommonly communicates with the thoracic duct. It either ends in the commencement of the right innominate vein, or it joins with the right jugular and right subclavian trunks, to form a short stem, the *right lymph duct*; but, as a rule, the three trunks open separately into the subclavian, the internal jugular, or the innominate vein (Parsons). The right broncho-mediastinal trunk conveys lymph from the upper part of the right lobe of the liver, the right side of the thorax, including the right pleura and lung and the right half of the heart, and, if a right lymphatic duct is formed it receives the lymph from the right upper extremity and the right side of the head and neck as well as the lymph carried by the broncho-mediastinal trunk.

Lymphoglandulæ Thoracales.—During the dissection of the thorax the dissector will have noted certain groups of lymph glands. These are of considerable importance, for their enlargement in disease is not infrequently the cause of serious thoracic trouble; but whilst some, such as the broncho-pulmonary and tracheo-bronchial glands, are quite obvious, others are frequently so small that they escape notice. The following are the chief groups:—(1) Two chains of minute glands which are placed in relation to the anterior thoracic wall along the course of the internal mammary vessels. They are termed *sternal lymph glands*, and are joined by lymph vessels from the anterior thoracic wall, the mammary glands, the anterior part of the diaphragm, and the upper part of the anterior wall of the abdomen. (2) Two chains of glands on the posterior thoracic wall—one on each side of the vertebral column in relation to the posterior parts of the intercostal spaces and the vertebral extremities of the ribs. These are very minute; they are called the *intercostal lymph glands*, and they receive the lymph vessels of the posterior thoracic wall. (3) *Lower anterior mediastinal lymph glands*, two or three in number, which receive lymph from the diaphragm and upper surface of the liver. They occupy the lower open part of the anterior mediastinum. (4) *Upper anterior mediastinal lymph glands*, an important group, eight to ten in number, and placed in relation to the aortic arch and the great vessels. They receive lymph from the heart, the pericardium, and the thymus. (5) *Posterior mediastinal lymph glands*, which follow the course of the thoracic aorta, and are joined by lymph vessels from the diaphragm-pericardium and œsophagus. (6) *Tracheo-bronchial* and *intertracheo*, *bronchial lymph glands*, associated with the intra-thoracic part of the trachea and the extra-pulmonary parts of the bronchi and the visceral pleura. (7) *Broncho-pulmonary lymph glands*, which lie in the hila of the lungs. (8) *Pulmonary lymph glands*, which are situated in the angles of division of the bronchi in the substance of the lung. The lymph from the lungs and the visceral pleura passes through the pulmonary, broncho-pulmonary, tracheo-bronchial, and intertracheo-bronchial glands, on the way towards the terminal lymph vessels. As it traverses the glands the carbon particles, which have passed from the air in the pulmonary alveoli and then through the walls of the alveoli and the walls of the lymph capillaries into the lymph in the lymph capillaries, are removed from the lymph by the cells of the lymph glands, and are deposited in their substance and in the stroma of the glands which, as a consequence, gradually become blacker and blacker as life continues.

Dissection.—Cut through the descending aorta immediately above the diaphragm. Detach its upper end from the left vagus and the left recurrent nerve, which were previously fastened to it; then draw it forwards and divide the intercostal and subcostal arteries, which arise from its posterior surface, close to their origins, and remove the aorta. The lateral parts of the aortic intercostal arteries have already been displayed (p. 40). Now clean their most medial parts and the transverse parts of the hemiazygos and accessory hemiazygos veins. Then proceed to the study of the aortic intercostal arteries and the revision of the intercostal veins and nerves.

Arteriæ Intercostales.—There are eleven pairs of intercostal arteries. The upper two pairs are derived indirectly from the subclavian arteries; the remaining nine pairs are branches of the thoracic part of the descending aorta.

The Aortic Intercostal Arteries.—The nine pairs of aortic intercostal arteries spring from the posterior surface of the descending aorta, either separately or by a series of common trunks, one for each pair. The right arteries are longer than the left because the aorta lies to the left of the median plane; and, since the descending aorta commences only at the level of the lower border of the fourth thoracic vertebra, the four or five highest pairs have to ascend to gain the level of the spaces to which they are distributed (Figs. 13 and 14).

The *right aortic intercostal arteries* run across the anterior aspects of the bodies of the vertebræ, lying posterior to the thoracic duct and the vena azygos; then they turn backwards, between the sides of the bodies of the vertebræ and the parietal pleura; and, finally, immediately before they enter the intercostal spaces, they pass between the sides of the bodies of the vertebræ medially and the sympathetic trunk laterally.

The shorter *left aortic intercostal arteries* run backwards, first between the left pleura and the bodies of the vertebræ, and then between the sympathetic trunk and the vertebral bodies.

As each artery enters the space to which it belongs it gives off a *posterior branch*, which passes backwards, between the vertebral column medially and the anterior costo-transverse ligament laterally; the posterior branch gives off a spinal twig, which enters the vertebral canal through the corresponding intervertebral foramen; then it divides into a medial and a lateral branch which accompany the medial and lateral divisions of the posterior ramus of the corresponding thoracic nerve. After giving off the posterior branch, the trunk of the artery runs laterally, along the upper border of the space to which it belongs, at first anterior to the posterior intercostal membrane, and then between the internal and external intercostal muscles. Its further course has been described already (p. 12). As it passes along the upper border of the intercostal space, in the shelter of the costal groove of the rib, it is situated between the intercostal vein above and the anterior ramus of the thoracic nerve below.

The Subcostal Arteries.—The subcostal arteries are the last pair of branches which spring from the posterior aspect of the thoracic part of the descending aorta. They enter the abdomen by passing behind the lateral lumbo-costal arches, and they run, in company with the last thoracic nerves, along the lower borders of the last pair of ribs in the walls of the abdomen (see p. 408).

Arteriæ Intercostales Supremæ.—The superior intercostal arteries, which supply the upper two intercostal spaces on each side, are derived from the costo-cervical branches of the subclavian arteries (Fig. 6). Each superior intercostal artery commences at the level of the upper border of the neck of the first rib. It descends anterior to the neck of the rib, posterior to the parietal pleura and between the first thoracic ganglion of the sympathetic trunk medially and the first thoracic nerve, which is passing upwards to the brachial plexus, laterally (Fig. 6). At the lower border of the neck of the first rib it gives off the posterior intercostal artery to the first intercostal space; then it crosses anterior to the neck of the second rib, and, turning laterally, it becomes the posterior intercostal artery of the second space.

Nervi Intercostales.—The intercostal nerves are the anterior rami of the thoracic nerves. They pass laterally, in company with the arteries. The twigs which connect them with the sympathetic ganglia have been noted already (p. 39). Each nerve lies at a lower level than the corresponding artery, and is, at first, placed between the posterior intercostal membrane and the pleura, and then between the two muscular strata. The positions occupied by the majority of the thoracic nerves and their general distribution have already been described (see p. 10), but the first, second, and last nerves of the thoracic region require special consideration.

The *first thoracic nerve* runs upwards, anterior to the neck of the first rib, to join the brachial plexus. It gives a small branch to the first intercostal space, but that branch, although it is disposed after the manner of an intercostal nerve, does not furnish, as a rule, a lateral cutaneous or an anterior cutaneous branch. The *second intercostal nerve*, as a rule, sends a branch upwards, anterior to the neck of the second rib, to join that portion of the first thoracic nerve which enters the brachial plexus. This communicating twig is usually insignificant, but sometimes it is a large nerve; when that is the case, the intercosto-brachial nerve (O.T. intercosto-humeral), or lateral cutaneous branch of the second intercostal nerve, is very small or altogether absent.

The Last Thoracic Nerve.—The twelfth thoracic nerve is distributed to the wall of the abdomen and to the buttock. It emerges from the vertebral canal between the last thoracic and the first lumbar vertebræ, and, almost at once, passes from the thorax to the abdomen behind the lateral lumbocostal arch (see p. 407) accompanying the subcostal artery.

Venæ Intercostales.—The *posterior intercostal veins* differ in their arrangement upon the two sides of the body. On the *right side* they terminate in three different ways:—

1. The highest intercostal vein, from the first or highest space, joins the *right innominate vein* (sometimes the *vertebral vein*), in the neck.
2. The intercostal veins of the second and third spaces (and sometimes that of the fourth space) unite into a common trunk, termed the *right superior intercostal vein*, which joins the upper part of the *vena azygos*.
3. The intercostal veins of the lower eight spaces oin the *vena azygos*.

On the *left side* of the body *four* modes of termination may be recognised:—

1. The highest intercostal vein, from the first space, joins the *left innominate vein* (sometimes the *vertebral vein*), in the neck.
2. The intercostal veins of the second and third spaces (and sometimes that of the fourth space) converge and by their union form a single trunk, termed the *left superior intercostal vein*, which crosses the arch of the aorta and joins the *left innominate vein* in the thorax. The union with the left innominate vein may be absent, and then the trunk formed by the veins of the second and third spaces joins the accessory hemiazygos vein.
3. The intercostal veins of the fourth, fifth, sixth, seventh, and eighth spaces terminate in the *accessory hemiazygos vein* (O.T. vena azygos minor superior), which crosses posterior to the aorta and joins the hemiazygos vein, or it ends directly in the vena azygos.
4. The intercostal veins of the ninth, tenth, and eleventh spaces join the *hemiazygos vein* (O.T. vena azygos minor inferior).

Vena Azygos (O.T. **Vena Azygos Major**).—The azygos vein has already been studied, but should now be revised (p. 41), and then the dissector should examine the hemiazygos and accessory hemiazygos veins.

Vena Hemiazygos Accessoria.—The accessory hemiazygos vein is formed, on the left side of the body, by the union of the intercostal veins of the fourth, fifth, sixth, seventh, and eighth spaces. It communicates above with the left superior intercostal vein, which carries the blood from the second and third intercostal spaces to the left innominate vein; and it receives the left bronchial veins. At the level of the eighth thoracic vertebra it crosses to the right, posterior to the aorta and thoracic duct, and ends by joining either the hemiazygos vein or the vena azygos. It is very irregular both as regards its tributaries and its termination.

Vena Hemiazygos (O.T. **Vena Azygos Minor Inferior**).—The hemiazygos vein takes origin within the abdomen. It is either the continuation upwards of the *left ascending lumbar vein* or it springs from the left renal vein. It enters the thorax by piercing the left crus of the diaphragm, and is continued upwards, upon the vertebral column, as far as the ninth or eighth thoracic vertebra. At that point it turns to the right, and, crossing posterior to the aorta and the thoracic duct, it joins the vena azygos. Before it terminates it may receive the accessory hemiazygos vein.

The thoracic tributaries of this vein are the intercostal veins of the lower three spaces of the left side and the left subcostal vein. In the abdomen it receives the upper two left lumbar veins.

The Anterior Intercostal Veins.—The anterior intercostal veins have already been referred to (p. 15). They draw blood from the anterior part of the thoracic wall by veins which accompany the intercostal branches of the internal mammary arteries, and they terminate in the internal mammary veins.

The veins of the thoracic parietes are extremely variable, and the description given above must be looked upon as representing merely their more usual arrangement.

THORACIC JOINTS.

The dissector should now complete the dissection of the thorax by an examination of the various thoracic joints.

Dissection.—When the portion of the sternum, with the cartilages of the ribs, which was laid aside, is studied, the following joints will be noted: inter-sternal, sterno-costal, and inter-chondral. Very little dissection is necessary. After the ligaments have been defined, the dissector should remove a thin slice from the anterior aspect of each articulation, in order that the interior of the joint may be displayed.

Synchondrosis Sternalis.—The joint between the manubrium and the body of the sternum is a synchondrosis. The opposing surfaces of bone are united by an intervening plate of cartilage. The joint is supported by some anterior and posterior longitudinal fibres which are developed in connection with the strong and thick periosteum. The posterior ligament is the stronger of the two. The joint between the body of the sternum and the xiphoid process is also a synchondrosis till middle life, at which period the two parts become ossified together.

Articulationes Sternocostales.—Seven ribs articulate with each side of the sternum by means of their cartilages.

The articulations of the first and the sixth are peculiar, inasmuch as they articulate with single pieces of the sternum, viz., with the manubrium and the lowest piece of the body, respectively; whereas each of the cartilages of the other true ribs articulates with two segments of the sternum. The cartilage of the first rib is implanted upon the side of the manubrium; there is no synovial cavity and the joint is a synchondrosis. The second costal cartilage is usually separated from the sternum by two synovial cavities, between which an interarticular ligament is developed. In the case of the other joints it is more common to find a single synovial cavity and no interarticular ligament. There is, however, considerable variety in these articulations, and a synovial stratum is very frequently wanting altogether in the joint between the seventh costal cartilage and the sternum.

With the exception of the first, which is a synchondrosis, the sterno-chondral joints belong to the diarthrodial variety. They are provided with anterior and posterior ligaments, and also, in those cases where the joint presents a double synovial cavity, with an interarticular ligament.

Ligamenta Sternocostalia Radiata.—The radiate sterno-costal ligaments are strong fibrous strands of the articular capsules of the sterno-costal joints. They radiate from the anterior and posterior surfaces of the sternal ends of the costal cartilages, from the second to the sixth, to the adjacent parts of the anterior and posterior surfaces of the sternum.

Ligamenta Sternocostalia Interarticularia.—The interarticular sterno-costal ligaments are feeble bands which attach the tips of the rib cartilages to the sides of the sternum. They divide the cavities of the joints in which they exist into upper and lower compartments each of which is lined with a synovial stratum.

Articulationes Interchondrales.—The interchondral joints are formed between the adjacent margins of the ribs, from the sixth to the tenth. The joint cavities are surrounded by ordinary articular capsules, each of which is lined internally with a synovial stratum; they are, therefore, diarthrodial joints.

Articulationes Costovertebrales.—The costo-vertebral joints are separable into two groups—articulationes capitulorum and articulationes costo-transversariæ.

The capitular articulations are the joints between the heads of the ribs and the bodies of the vertebræ and the intervertebral fibro-cartilages; they are diarthrodial joints. With the exceptions of the first rib and the last three ribs, the head of every rib articulates with the bodies of two adjacent vertebræ and the intervening intervertebral fibro-cartilage, and it is connected with them by an articular capsule and an interarticular ligament. The interarticular ligament connects the intervertebral fibro-cartilage with the ridge which separates the two facets on the head of the rib. It is united, anteriorly and posteriorly, with the capsule, and separates the joint cavity into an upper and a lower compartment. The anterior part of the capsule is specialised into three radiating bands which form the *radiate ligament* (lig. capituli costæ radiatum). The upper and lower bands go to the corresponding vertebræ, whilst the intermediate band is attached to the intervertebral fibro-cartilage. The capitular joints of the first, and the tenth, eleventh, and twelfth ribs are each formed between the head of the rib and the corresponding vertebra. The interarticular ligament is absent; therefore each joint possesses only one

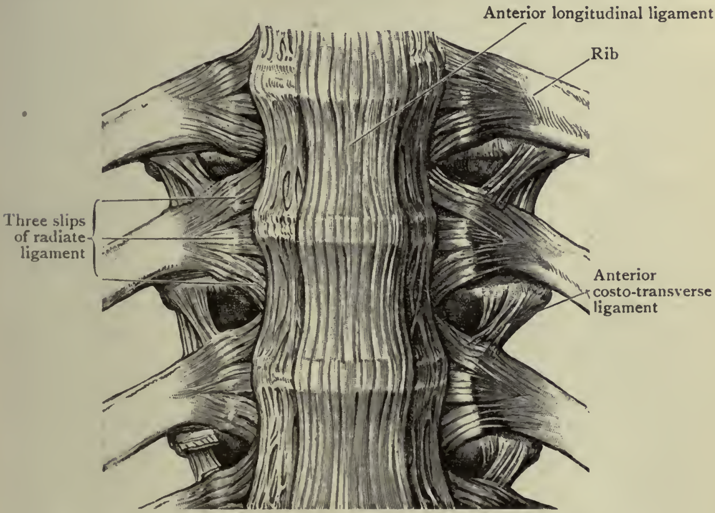


FIG. 72.—Anterior aspect of the Costo-vertebral Joints and of the Anterior Longitudinal Ligament of Vertebral Column.

cavity. The anterior parts of the capsules of those joints are not, as a rule, specialised into radiate bands.

The Costo-transverse Articulations are the joints formed between the necks and tubercles of the ribs and the transverse processes of the vertebræ.

The tubercle of each rib, with the exception of the eleventh and twelfth, articulates with the tip of the transverse process of the vertebra of the same number, by a circular articular facet which is surrounded by an articular capsule lined with a synovial stratum. The joint is, therefore, a diarthrodial joint, and the upper and posterior part of the capsule is greatly thickened, and is called the *ligament of the tubercle* (lig. tuberculi costæ) (O.T. *posterior costo-transverse ligament*). In addition to the capsule and its posterior thickening, there are three accessory costo-transverse bands, the anterior and posterior costo-transverse ligaments and the ligament of the neck of the rib.

Ligamentum Costo-transversarium Anterius.—The anterior costo-transverse ligament ascends from the anterior margin of the upper border of the neck of the rib to the lower border of the transverse process above.

Ligamentum Costo-transversarium Posterius.—The posterior costo-transverse ligament passes upwards from the posterior part of the upper border of the neck of the rib to the junction of the lamina and the transverse process of the vertebra above.

Ligamentum Colli Costæ.—The ligament of the neck of the rib (O.T. *middle costo-transverse ligament*) connects the posterior aspect of the neck of the rib with the anterior aspect of the transverse process of the vertebra of the same number.

In the case of the eleventh rib the costo-transverse ligaments are rudimentary or absent, and in the case of the twelfth rib they are usually entirely absent.

Intervertebral Articulations.—The *bodies* of the vertebræ are held together by a series of synchondrodial joints, supported anteriorly by an anterior longitudinal ligament, and posteriorly by a posterior longitudinal ligament. The *vertebral arches*, by means of the articular processes, form a series of diarthrodial joints surrounded by articular capsules, each capsule being lined with a synovial stratum. Certain ligaments pass between different portions of the vertebral arches and their processes, viz., the ligamenta flava, between adjacent laminæ, and the inter-transverse, the inter-spinous, and the supra-spinous ligaments.

As the laminæ and the spinous processes of the vertebræ were removed by the dissector of the head and neck when the vertebral canal was opened to display the spinal medulla, the ligamenta flava, the inter-spinous and supra-spinous ligaments cannot be seen at present.

Ligamentum Longitudinale Anterius.—The anterior longitudinal ligament (O.T. *anterior common ligament*) is situated in front of the bodies of the vertebræ, extending from the atlas vertebra above to the first piece of the sacrum below. It consists of stout glistening fibrous bands, which are firmly attached to the margins of the vertebral bodies and to the intervertebral fibro-cartilages. The most superficial fibres are the longest, and extend from a given vertebra to the fourth or fifth below it. The deeper fibres have a shorter course, and pass between the borders of two or three adjacent vertebræ. The dissectors cannot fail to notice that the origins of the longus colli muscles are closely connected with the upper part of the thoracic portion of the ligament.

Ligamentum Longitudinale Posterius.—The posterior longitudinal ligament (O.T. *posterior common ligament*) covers the posterior aspects of the vertebral bodies, and is therefore within the vertebral canal. It is firmly connected to the margins of the vertebral bodies and to the intervertebral fibro-cartilages, but is separated from the central parts of the bodies by some loose connective tissue and by a plexus of veins. It is narrow where it covers the venous plexus, but widens out opposite the fibro-cartilages. It therefore presents a scalloped or denticulated appearance.

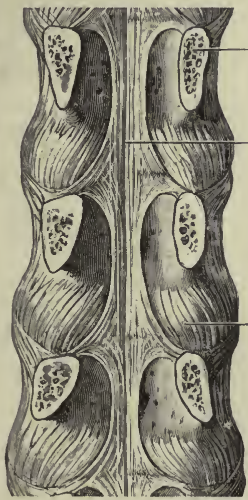


FIG. 73.—Posterior Longitudinal Ligament of the Vertebral Column. The vertebral arches have been removed from the vertebræ.

The *intervertebral fibro-cartilages* are a series of discs of white fibro-cartilage which are interposed between the bodies of adjacent vertebræ. They are thicker posteriorly than anteriorly in the thoracic region. The peripheral part of each disc, the *annulus fibrosus*, is tough and fibrous; the central portion, the *nucleus pulposus*, is soft and pulpy. The discs increase the elasticity of the vertebral column, and tend to restore it to its natural curvature after it has been deflected by muscular action.

The intervertebral fibro-cartilages constitute the main bond of union between the bodies of the vertebræ, but, except in old people, they are not directly attached to the bone. A thin layer of encrusting hyaline cartilage coats the opposing vertebral surfaces.

Vertical and horizontal sections must be made through two or more of the fibro-cartilages, in order that their structure may be displayed.

Ligamenta Intertransversaria.—The intertransverse ligaments are feeble bands which pass between the tips of the transverse processes. In the lower part of the thoracic region they are intimately blended with the intertransverse muscles: in the middle and upper parts of the thoracic region they entirely replace those muscles.

ABDOMEN.

WHEN the body is brought into the dissecting-room, it is first placed in the lithotomy position (Fig. 75), and is retained in that posture for three days, during which time the dissector of the abdomen must dissect the *perineum.*

MALE PERINEUM.

Boundaries of the Perineum.—The perineum is the region of the inferior end of the trunk between the thighs. It corresponds with the inferior aperture or outlet of the pelvis

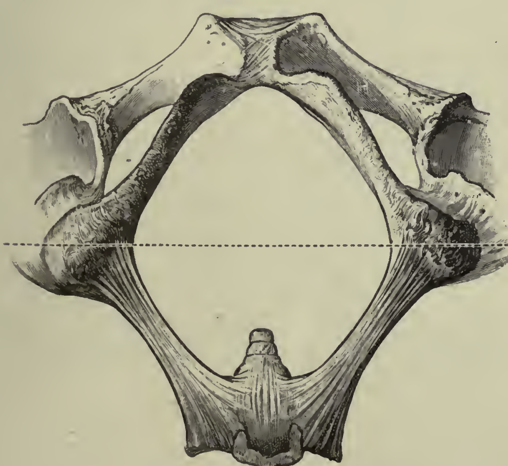


FIG. 74.—Inferior Aperture of Male Pelvis.

and it is necessary, therefore, that the dissectors should renew their acquaintance with that part of the skeleton before they begin the dissection. Having obtained a pelvis, with the ligaments *in situ*, they will note that the inferior aperture of the pelvis is a diamond-shaped space which has the following boundaries: *anteriorly*, the symphysis pubis and the arcuate pubic ligament (O.T. sub-pubic); *posteriorly*, the coccyx; and *on each side*, from before backwards, the rami of the pubis and ischium, the tuberosity of the ischium, and the sacro-tuberous ligament (O.T. great sciatic). If they now turn their attention to the subject before them they can identify the extent and limits of the space without difficulty. The sacro-tuberous ligament, however, is somewhat obscured, because it is covered by the glutæus maximus muscle, but it can be felt if deep pressure is made in a line between the ischial tuberosity and the coccyx (Figs. 74 and 75).

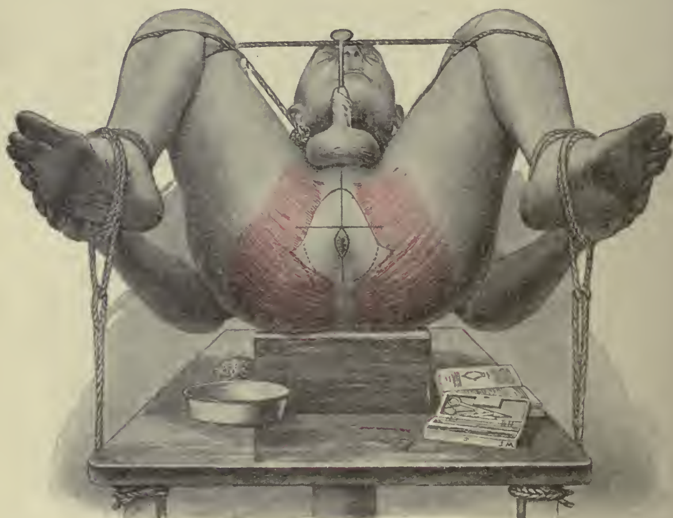


FIG. 75.—Body in Perineal Posture.

In the undissected body, standing in the erect posture, the superficial area of the perineum is very limited. It consists merely of a narrow groove running forwards between the the thighs from the coccyx towards the pubis. In the groove lie the anus, which is the orifice of the anal canal, and the roots of the scrotum and penis, whilst in the middle line a cutaneous ridge called the *median raphe of the perineum* can be seen. The raphe can be traced from the front of the anus forwards over the scrotum and along the inferior surface of the penis. It is of special interest because it marks the line along which the inferior wall of the urethra was completed and the two halves of the scrotum fused together. It corresponds in position with the urogenital cleft of the female.

Subdivision of the Space.—It is customary to subdivide the diamond-shaped perineal space into two portions by drawing an imaginary transverse line between the anterior parts of the ischial tuberosities, immediately in front of the anus. Two triangles are thus mapped out. The anterior of the two may be appropriately called the *urogenital triangle*, because the most important objects which it contains are the urethra and the root of the penis; the posterior is distinguished as the *anal triangle*, because it contains the anal canal.

Preparation of the Perineum for Dissection.—After the boundaries of the perineum have been defined, and before the dissection is commenced, a staff must be passed along the urethra into the bladder, the anal canal must be slightly distended and the anal orifice stitched up.

Having obtained a staff, oil it or smear it with vaseline, and hold it in the right hand, stand on the left side of the body and seize the penis with the left hand. Hold the staff at right angles to the long axis of the body, introduce its point into the orifice of the urethra and pass it along the urethra, keeping it in contact with the floor of the canal and guiding it with the fingers of the left hand until it arrives at a point about midway between the root of the scrotum and the anus—the *central point of the perineum.* When the point of the staff has reached the central point of the perineum it has passed through the third or penile portion of the urethra. It has now to be passed through the second or membranous part and the first or prostatic part. In order to make it traverse those parts successfully the following steps must be taken: (1) Rotate the staff through quarter of a circle, carrying the handle across the lower part of the abdomen until it lies in the median plane of the body. (2) Steady the point of the staff with a finger of the left hand and with the right hand carry the handle of the staff downwards towards the perineum. If the manœuvre is successful the point of the staff will rise slightly and will pass through the membranous and prostatic parts of the urethra into the bladder. No force must be used. If any difficulty is experienced, and the point of the staff will not enter the membranous urethra, introduce the index finger of the left hand into the anal canal and again endeavour to guide the point of the staff in the proper direction. It is possible that stricture of the urethra due to disease may prevent the passage of the staff. In that case the dissectors should seek an opportunity of passing the staff in a more satisfactory

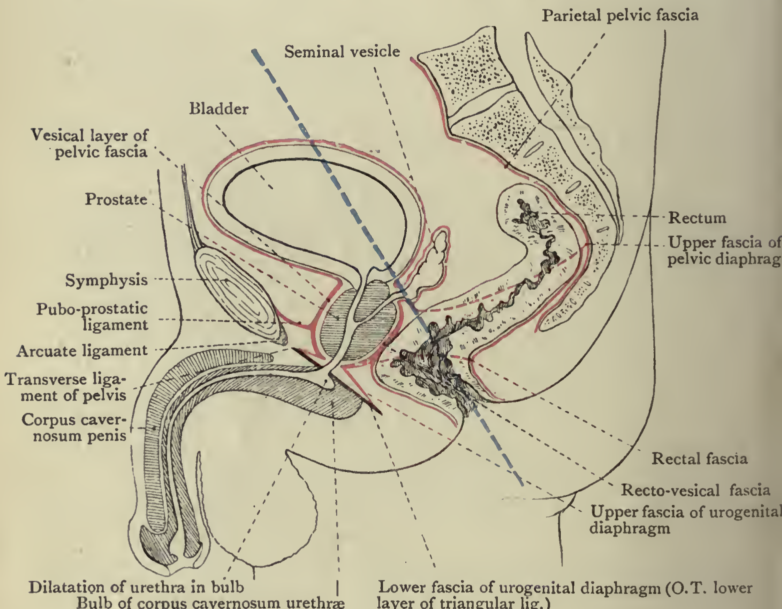


FIG. 76.—Diagram of Urinary Bladder and Urethra.

body. The dissectors should note that the point of the staff is kept to the floor of the canal as it is passed through the penile part of the urethra, because there are depressions in the roof in which it might catch; and that, because there is a depression in the floor of the penile part of the canal, immediately in front of the termination of the membranous part, the tip of the staff must be raised as it is passed from the penile into the membranous part.

When the staff has been passed note that it can be felt through the skin quite easily, as far back as the central point of the perineum, but no further. Now pass a finger through the anus into the anal canal and note that the staff, as it lies in the membranous part of the urethra, is again quite easily felt; but, at a higher level, as it passes through the prostatic part of the urethra, it is less distinctly felt because it is covered by the posterior part of the prostate.

After the staff has been successfully passed and its surroundings have been investigated with the finger, stitch the most dependent part of the scrotum to the prepuce of the penis, then drag both penis and scrotum forwards on the staff and tie them in position. Next tie the handle of the staff to the cord which passes between the flexed knee-joints of the subject. Lastly introduce a *little* tow, steeped in preservative fluid, into the anal canal and stitch up the orifice of the anus.

***Dissection*.—Reflection of Skin.—Two incisions are required (Fig. 75):—(1) a transverse incision along the line which separates the *anal* from the *urogenital* triangle—*i.e.* in front of the ischial tuberosities; (2) an incision at right angles to the first, in the line of the median raphe. The second incision should begin well forwards on the scrotum and be continued back a little beyond the point of the coccyx. The knife should be carried round the anus so as to encircle it.**

The four triangular flaps which are marked out should now be reflected. Commence the reflection of each flap at its apex. Some difficulty will be experienced in raising the posterior flaps. It is due to the presence of a number of fasciculi of involuntary muscle which radiate outwards from the anus. They form collectively the *corrugator cutis ani*. When the skin has been reflected the *superficial fascia* and the *external sphincter muscle* will be exposed.

Panniculus Adiposus (Superficial Fascia).—The dissectors must examine the superficial fascia carefully. It shows great differences in character and texture in different parts of the perineal area. At the sides of the anal canal in the ischio-rectal fossæ, which lie between the anal canal and the tuberosities of the ischia, it is remarkable for the large quantity of fat it holds in its meshes. That fat is soft and lobulated, and passes upwards upon each side of the anal canal in the form of a pliable and elastic pad. Over the ischial tuberosities the superficial fascia undergoes a striking alteration. In those situations it becomes tough and stringy; dense fibrous septa separate the lobules of fat from one another and connect the skin with the subjacent bone, and it acts as cushions upon which the tuberosities of the ischia rest when the body is in the sitting posture. Intervening between the fascia and each tuberosity there is a bursa, which may be displayed by an incision carried through the fascia to the bone. Not uncommonly the cavity of the bursa is divided into many loculi by intersecting fibrous septa.

In the anterior part of the perineal region, that is in the urogenital area, another change in the character of the superficial fascia becomes manifest. The farther forwards it is traced the scarcer becomes the fat which it contains in its meshes. In the scrotum the fat entirely disappears and gives place to a thin layer of involuntary muscular fibres, which constitute the *dartos muscle.* They are recognised by their ruddy colour. The rugosity of the scrotal integument is caused by their contraction.

Over the urogenital triangle also the superficial fascia can be shown to consist of two very definite layers. The *superficial layer* is fatty and is not confined to that part of the perineal region. In fact, it is simply a portion of the general fatty covering of the body. Posteriorly, it is continuous with the plugs of fat which fill up the ischio-rectal fossæ; on each side, it leaves the perineum and becomes continuous with the fatty tissue on the medial aspects of the thighs. The *deep layer* is of an altogether different nature. It is a dense membranaceous stratum spread over the urogenital triangle, and it is devoid of fat. It is called the *fascia of Colles.*

The fascia of Colles has very definite attachments and connections. On each side it is attached to the rami of the pubis and ischium. Posteriorly it turns round the two superficial transverse perineal muscles, which extend from the rami of the ischia to the central point of the perineum (Fig. 77), and then blends with the base of the fascia of the urogenital diaphragm, which fills in the urogenital part of the outlet of the pelvis on a deeper plane than that occupied by the fascia of Colles. Towards the front of the perineum the fascia of Colles is continuous with the dartos tissue of the scrotum, and that in its turn is continuous more anteriorly with the fascia of Scarpa, which is the deep layer of the superficial fascia of the abdomen. Laterally both the fascia of Colles and the fascia of the urogenital diaphragm are attached to the rami of the pubis and ischium, and the attachment of the fascia of Colles is prolonged upwards, as it becomes continuous with the fascia of Scarpa, along the front of the symphysis pubis on each side. In the anterior

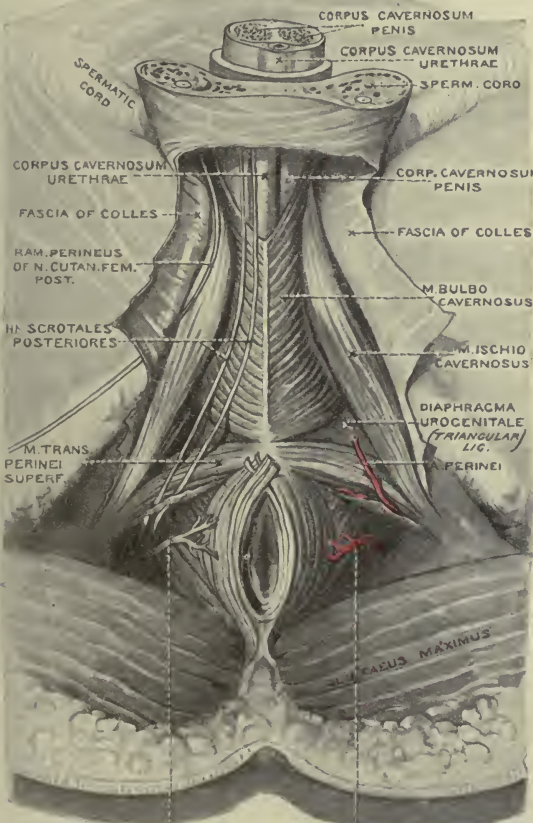


FIG. 77.—Dissection of the Perineum. The Scrotum and the Penis have been cut transversely across and removed.

part of the perineum, therefore, a definite pouch, called the *superficial pouch of the perineum*, is formed. It is bounded *superficially* by the fascia of Colles, *deeply* by the inferior fascia of the urogenital diaphragm, laterally by the attachment of both to the sides of the pubic arch. It is closed *posteriorly* by the fusion of the fascia of Colles with the base of the fasciæ of the urogenital diaphragm, but it is open above and in front, across the front of the symphysis pubis, where its cavity is continuous with the areolar tissue-filled interval between the superficial and the deep fascia of the anterior wall of the abdomen. Within the pouch certain important parts are placed—viz., the superficial perineal muscles, the perineal vessels and the scrotal nerves, the long perineal branch of the posterior cutaneous nerve of the thigh, the bulb of the urethra, the crura of the penis, and the termination of the internal pudendal artery. The pouch is partially divided into right and left halves by a median septum, which dips from the fascia of Colles to the inferior surface of the bulb of the urethra. The septum is very perfect posteriorly, but it becomes incomplete towards the scrotum. Anteriorly, the fascia of Colles passes over the scrotum, penis, and spermatic cords, to the anterior aspect of the abdomen, where it becomes continuous with the fascia of Scarpa.

It follows, from what has already been stated, that if the posterior part of the penile portion of the urethra is injured and urine escapes from it, to one or other side of the median plane, it will first distend the corresponding half of the posterior part of the superficial pouch, next, having reached the limit of the septum, it will distend the opposite half. Then because it cannot escape either posteriorly or laterally on account of the attachments of the fasciæ, it will push its way forwards and upwards into the areolar tissue between the superficial and deep fascia of the abdominal wall, and it may ascend as far as the thorax unless exit is made for it by free incisions, through the skin and superficial fascia, into the pouch. The extravasated urine which has reached the wall of the abdomen cannot descend into the thighs because of the attachment of Scarpa's fascia to the fascia lata near the inguinal ligaments.

Dissection.—The student can verify the above-mentioned facts in two ways, viz.—(1) by inflating the pouch with air, and (2) by dissection. Make a longitudinal incision, large enough to admit the nozzle of the bellows (or, better still, an injection pipe fitted to a bicycle-pump), into the superficial fascia, towards the posterior part of the pouch and a little to one side of the middle line. The cut must be carried through the fascia until the fibres of the superficial perineal muscles are exposed. Introduce the nozzle of the bellows, or injection pipe, through the incision and compress the margins of the opening round it, then force air into the pouch. The air which is introduced first will fill one side of the pouch, then it will pass forwards to the scrotum, where the septum is incomplete, and will force its way across the median plane to the opposite side. Afterwards, as more air is forced in, it will pass forwards to the abdomen. The pouch is thus rendered prominent and the attachments of the fascia of Colles become evident. The air cannot pass into the anal triangle owing to the union of the fascia of Colles with the base of the fascia of the urogenital diaphragm ; it cannot pass down the medial aspect of the thighs, on account of the attachment of the fasciæ to the sides of the pubic arch ; it can only force its way forwards under the superficial fascia and dartos muscle of the scrotum, and thence on to the penis and the anterior aspect of the abdomen. By the means suggested the dissector will obtain a very striking view of the course which would be taken by urine escaping from a rupture in the urethra below the urogenital diaphragm.

The attachments of the fascia of Colles are so important that the student should test them by dissection also. To do that it is necessary to make two incisions through the superficial fascia. Enter the knife in the middle line at the root of the scrotum, and carry it backwards and laterally to the tuber ischii on each side of the body. A central $\wedge$-shaped flap and two collateral flaps of fascia are thus marked out. When the central portion is raised and turned backwards, the septum of the pouch is brought into view, and the attachment of the fascia to the base of the urogenital diaphragm is demonstrated. When the collateral flaps are turned aside each will be seen to be firmly fixed to the border of the pubic arch. As this dissection is made the utmost care is demanded on the part of the dissector. In the areolar tissue immediately subjacent to the superficial fascia are the *superficial perineal vessels* and *scrotal nerves*, which are certain to be injured, or perhaps even reflected with the fascia, unless the greatest caution is exercised.

Anal Triangle.

The dissection of the anal portion of the perineal space will disclose the following parts :—

1. The external sphincter ani muscle.
2. The anal canal, covered by the levator ani muscle and the inferior fascia of the pelvic diaphragm.
3. The obturator fascia.
4. The lower border of the glutæus maximus muscle and the ligamentum sacro-tuberosum (O.T. great sacro-sciatic).
5. The ano-coccygeal body.
6. The inferior hæmorrhoidal vessels and nerve.
7. The perineal artery.
8. The perineal branch of the fourth sacral nerve.
9. The perineal nerve and its branches.
10. The perforating cutaneous branch of the second and third sacral nerves.

Dissection.—Clean the sphincter ani externus. Make an incision through the fascia which covers the muscle, from the tip of the coccyx to the anus, carry it forwards round the sides of the stitches which were used to close the anus, and then onwards to the central point of the perineum in the median plane. Reflect the fascia to each side and, as the borders of the muscle are defined, secure the branches of the inferior hæmorrhoidal nerve and artery and the perineal branch of the fourth sacral nerve, which supply the muscle.

M. Sphincter Ani Externus.—When the external sphincter muscle of the anus is cleaned it will be seen to consist of a thick ring of muscular fibres which surround the orifice of the anal canal. *Posteriorly*, it is attached, by a pointed tendon, to the tip and posterior surface of the terminal part of the coccyx; *anteriorly*, it blends with other perineal muscles in the central point of the perineum. As the fibres pass between the two points of attachment, they encircle the anal orifice and form a true sphincter muscle. Some of the superficial fibres, both in front of and behind the anal opening, are directly attached to the skin. It draws its nervous supply from two sources, viz., the *fourth sacral nerve* and the *inferior hæmorrhoidal nerve.*

FIG. 78.—Diagram. The arrow is directed upwards into the ischio-rectal fossa. The parietal pelvic fascia is seen upon the medial surface of the obturator internus. Observe also the inferior fascia of the pelvic diaphragm clothing the lateral surface of the levator ani and the rectal fascia upon its medial surface.

Contents of the Anal Triangle.—The next step in the dissection of the perineum is the display of the *ischio-rectal fossæ* and their contents, but before the dissection is commenced the dissectors should have a general idea of the position and contents of the fossæ.

Passing through the middle of the anal triangle of the perineum is the anal canal, which terminates at the anus.

It is covered on each side by the levatores ani and coccygei muscles and their fasciæ; but the canal and the muscles which cover it occupy only the middle part of the triangle, and on each side between the muscles covering the canal and the lateral boundary of the triangle lies an *ischio-rectal fossa.* The fossa is bounded, *medially* by the levator ani and the coccygeus, *laterally* by the ischium covered by the obturator internus and the obturator fascia, *posteriorly* by the inferior borders of the glutæus maximus and the sacro-tuberous ligament, and *anteriorly* by the base of the fascia of the urogenital diaphragm blended with the posterior border of the fascia of Colles. Each ischio-rectal fossa is filled with a pad of soft elastic fat in which lie the inferior hæmorrhoidal vessels, accompanied by the inferior hæmorrhoidal nerve, the perineal branch of the fourth sacral nerve, portions of the superficial and deep branches of the perineal nerve and the accompanying rami of the perineal branch of the pudendal artery. All the structures mentioned must now be displayed.

Dissection.—Begin, on each side, by exposing the inferior margin of the glutæus maximus muscle, which forms one of the posterior boundaries of the fossa. Take a point a short distance to the lateral side of the ischial tuberosity and another in the median plane about an inch above the tip of the coccyx, and cut boldly down through the superficial fascia, in a line between those points, until the deep fascia covering the fleshy fibres becomes visible. Winding round the margin of the muscle, so as to gain its superficial aspect, there are a few small arteries and nerves. The arteries are derived from the *inferior hæmorrhoidal vessels*, or from the *inferior gluteal artery*, whilst the nerves are the *perforating cutaneous branch* from the second and third sacral nerves and some offsets from the *posterior cutaneous nerve of the thigh.* All are destined for the supply of the skin over the inferior part of the gluteal region. The perforating cutaneous nerve turns round the margin of the glutæus maximus near the coccyx, whilst the gluteal branches from the posterior cutaneous nerve of the thigh appear on the lateral side of the tuber ischiadicum. When the vessels and nerves mentioned have been secured, clean the lower border of the glutæus maximus, then push the fat in the fossa in front of it forwards, pull the muscle backwards and expose and clean the lower border of the sacro-tuberous ligament, which lies under cover of the muscle. After the margin of the sacro-tuberous ligament has been defined, detach the fat from the lateral wall of the fossa, partly with the aid of the blade and partly with the aid of the handle of the scalpel, and push it forwards and medially, but be careful not to injure any vessels or nerves. When the fat has been detached from the posterior and lateral walls of the fossæ carry the knife obliquely forwards and medially in the fat, from the angle between the glutæus maximus and the ischial tuberosity towards the anus, and secure the inferior hæmorrhoidal vessels and nerves. Follow them to their termination in the medial wall, in the sphincter ani externus and the levator ani muscles. Next turn to the anterior part of the lateral wall of the fossa, dissect carefully in the angle between it and the base of the urogenital diaphragm and find the lateral and medial posterior scrotal branches of the superficial division of the perineal nerve (posterior labial nerves of female), and the scrotal branches (labial in female) of the perineal artery which accompany the nerves. Find also the deep division of the perineal nerve and the transverse perineal artery. The posterior scrotal nerves and arteries (posterior labial in female) pierce the fascia of Colles as it blends with the base of the fascia of the urogenital diaphragm, the deep branch of the perineal nerve pierces the base of the fascia of the urogenital diaphragm, and the transverse perineal artery runs along the posterior border of the diaphragm.

The perineal branch of the fourth sacral nerve must be sought about a finger's breadth from the tip of the coccyx. It pierces the coccygeus muscle and runs downwards and forwards to the external sphincter ani. After the nerves and vessels have been found and cleaned the remains of the fat must be removed from the fossa and its boundaries and contents must be studied.

Ischio-rectal Fossæ.—There are two ischio-rectal fossæ, right and left. *Position.*—Each fossa lies in the anal triangle of the perineum between the anal canal of the rectum and the ischium, but neither the anal canal nor the ischium enters directly into the formation of the walls of the fossa, for both are separated from the cavity of the space by fascial and muscular layers.

The anal canal is covered by the superior fascia of the pelvic diaphragm (O.T. rectal layer of the visceral portion of the pelvic fascia), the levator ani and the inferior fascia of the pelvic diaphragm (O.T. anal fascia)—in that order from the medial to the lateral side. The medial aspect of the ischium is separated from the cavity of the fossa by the obturator internus muscle and by the obturator fascia, which covers the muscle and binds it to the bone.

Shape.—Each ischio-rectal fossa is pyramidal in shape. The apex is above, towards the cavity of the pelvis, the base below, at the integument of the perineum. The medial wall slopes upwards and laterally. The lateral wall ascends vertically from the tuber ischii and meets the medial wall at the apex of the fossa.

Boundaries.—Speaking strictly, the *medial wall* of the fossa is formed by the inferior fascia of the pelvic diaphragm which covers the lower surfaces of the levator ani and the coccygeus muscles. The *lateral wall* is formed by the obturator fascia, which clothes the medial surface of the obturator internus. At the *apex* or *roof* the obturator fascia blends with the inferior fascia of the pelvic diaphragm. The *anterior boundary* is the base of the fascia of the urogenital diaphragm and the transversus perinei muscle which runs along its superficial aspect. The *posterior boundary* is formed by the inferior borders of the sacro-tuberous ligament and the glutæus maximus muscle. The *inferior boundary* is the tough integument of the posterior part of the perineum.

The fossa is widest and deepest posteriorly, and narrowest and most shallow in front, where it is prolonged forwards, above the base of the fascia of the urogenital diaphragm.

In its lateral wall, in a canal in the obturator fascia,[1] 35-40 mm. above the lower margin of the ischial tuberosity, lie the internal pudendal artery and its venæ comites with the perineal nerve below them and the dorsal nerve of the penis above them. The inferior hæmorrhoidal branch of the pudendal nerve and the accompanying inferior hæmorrhoidal branch of the internal pudendal artery pierce the fascia of the lateral wall posteriorly, and the superficial and deep terminal branches of the perineal branch of the pudendal nerve and the perineal and transverse perineal branches of the internal pudendal artery pierce it anteriorly. The perineal branch of the fourth sacral nerve pierces the lower part of the coccygeus muscle in the medial wall.

The contents of the fossa are :—(1) An elastic pad of fat, which fills the cavity. (2) The inferior hæmorrhoidal vessels and nerves which traverse the fat on their way from the postero-lateral angle to the medial wall of the fossa. (3) Portions of the posterior scrotal (labial) branches of the superficial division of the perineal nerve. (4) The deep division of the perineal nerve. (5) The perineal and transverse perineal arteries, in the anterior angle. (6) The perineal branch of the fourth sacral nerve is at the postero-medial angle. (7) Turning round the inferior border of the glutæus maximus, between the coccyx and the ischium, the perforating cutaneous branch from the second and third sacral nerves.

The fat which fills the fossa acts as an elastic pad which allows the anal passage to expand as the fæces are expelled through it, and assists it in closing the canal after the fæces have passed.

[1] O.T. Alcock's canal.

The weakest wall of the fossa is the medial wall, which is formed by muscles and fasciæ only; therefore if an abscess forms in the fossa the contents of the abscess are apt to force their way into the anal canal, unless an exit is made for them through the skin of the base of the fossa.

Arteria Pudenda Interna et Nervus Pudendus.—If the dissector passes his index finger upwards and downwards over the obturator fascia, which forms the lateral wall of the ischio-rectal fossa, he will feel a ridge which runs from behind forwards. It lies about 38 mm. (one and a half inches) above the inferior border of the ischial tuberosity, and is caused by the internal pudendal artery and the accompanying perineal nerve and the dorsal nerve of the penis, which are branches of the pudendal nerve. At the posterior end of the ridge the inferior hæmorrhoidal artery and nerve will be found piercing the wall of the fascial canal and passing into the fossa, and at the anterior end the superficial and deep terminal branches of the perineal nerve and the perineal and transverse perineal branches of the internal pudendal artery pierce the medial wall of the canal as they enter the fossa. For the present the dissector must be satisfied with palpating the structures which lie in the canal. To expose them it would be necessary to divide the obturator fascia, and that must be kept intact until the pelvic fascia can be studied as a whole. In the meantime, however, the dissector should recall to mind the fact that he displayed the pudendal nerve and the internal pudendal artery during the dissection of the buttock, when he cleaned the structures exposed by the reflection of the glutæus maximus (see Vol. I. p. 287). There they rested on the spine of the ischium or the sacro-spinous ligament and disappeared into the perineum through the lesser sciatic foramen. Now they are met with again as they lie in a canal in the obturator fascia in the lateral wall of the ischio-rectal fossa, where the nerve divides into the inferior hæmorrhoidal nerve, the perineal nerve, and the dorsal nerve of the penis, and the artery gives off inferior hæmorrhoidal, perineal, and transverse perineal branches. At the anterior end of the ischio-rectal fossa the canal in the obturator fascia opens into the space between the two layers of fascia of the urogenital diaphragm, and the internal pudendal artery and the dorsal nerve of the penis pass into that space, where they will be dissected later.

Arteriæ Hæmorrhoidales Inferiores.—The inferior hæmorrhoidal arteries, usually two or three in number, are branches of the internal pudendal. They pierce the medial wall of the canal in the obturator fascia, and pass medially, through the fat of the ischio-rectal fossa, to supply the anal canal and the muscles in connection with it, as well as the skin around the anus. Around the anal canal they anastomose with the corresponding arteries of the opposite side, and with branches from the middle and superior hæmorrhoidal arteries. They also send a few twigs round the lower border of the glutæus maximus, in company with the perforating cutaneous nerve, to supply the skin of the lower part of the buttock.

N. Hæmorrhoidalis Inferior.—The inferior hæmorrhoidal nerve accompanies the vessels of the same name. It may proceed directly from the sacral plexus, but more frequently it is a branch of the pudendal nerve. It perforates the medial wall of the canal in the obturator fascia, enters the ischio-rectal fossa, and then it breaks up into muscular, cutaneous, and communicating branches. The *muscular twigs* supply the external sphincter ani; the *cutaneous offsets* are given to the skin which surrounds the anus; while the *communicating filaments* pass forwards to join the scrotal nerves and the long perineal branch of the posterior cutaneous nerve of the thigh.

Perineal Branch of Fourth Sacral Nerve.—The perineal branch of the fourth sacral nerve is small. It enters the ischio-rectal fossa by piercing the coccygeus muscle at the side of the coccyx. It is distributed to the skin between the anus and coccyx, and to the external sphincter ani muscle.

The perineal artery and the superficial and deep branch of the perineal nerve, which were found in the anterior angle of the fossa close to the lateral wall, will be traced forwards, in the next stage of the dissection, in the urogenital triangle.

Ano-coccygeal Body.—An indefinite mass of muscular and fibrous tissue which lies between the tip of the coccyx and the anus receives the name of *ano-coccygeal body.* It is seen best in sections through the pelvis, and it requires notice on account of the support which it gives to the lower part of the rectum and the anal canal. The muscular tissue which enters into its constitution belongs to the levator ani and the external and internal sphincter muscles (Symington).

Urogenital Triangle.

The superficial fascia of the urogenital triangle has already been studied (p. 151). The following structures which lie in the area still require to be dissected :—

1. The posterior scrotal vessels and nerves.
2. The long perineal branch of the posterior cutaneous nerve of the thigh.
3. The root of the penis. {The bulb of the urethra and the crura.
4. The superficial perineal muscles.
   - *a.* Superficial transverse perineal muscle.
   - *b.* Bulbo-cavernosus muscle.
   - *c.* Ischio-cavernosus muscle.
5. Inferior fascia of the urogenital diaphragm.
6. The internal pudendal vessels and their branches and the pudendal nerve and its branches.
7. The deep transverse perineal muscle and the sphincter of the membranous urethra.
8. The bulbo-urethral glands.
9. The membranous portion of the urethra.
10. Superior fascia of the urogenital diaphragm.

***Dissection.*—Clear away the remains of the fascia of Colles from the urogenital triangle; then clean the perineal artery and follow its terminal scrotal branches to the scrotum. Clean also the posterior scrotal branches of the superficial division of the perineal nerve, and whilst cleaning them find the long perineal branch of the posterior cutaneous nerve of the thigh. It communicates with the posterior scrotal nerves in the perineal pouch. When it is found, trace its terminal branches to the scrotum, and trace its trunk backwards to the point where it enters the superficial pouch of the perineum by piercing the fascia of Colles, about 25 mm. (one inch) anterior to the tuberosity of the ischium. As the nerves are followed three muscles will be more or less displayed :—Along the margin of the pubic arch the ischio-cavernosus; near the median plane the bulbo-cavernosus; and, crossing between their posterior extremities, the superficial transverse perineal muscle.**

Superficial Arteries and Nerves.—

Arteries.
1. The perineal artery.
2. The transverse branch of the perineal artery.

Nerves.
1. The posterior scrotal nerves.
2. The long perineal branch of the posterior cutaneous nerve of the thigh.

The *perineal artery*, a branch of the pudendal, pierces first the medial wall of the canal in the obturator fascia, then the base of Colles' fascia, and so it gains the interior of the perineal pouch of fascia. In the pouch it crosses superficial to the transversus perinei muscle, and is continued forwards, in the interval between the bulbo-cavernosus and ischio-cavernosus muscles, to the scrotum, to the dartos muscle and integument of which it is distributed in the form of numerous long, slender branches, called the *posterior scrotal arteries*. Before it reaches the scrotum, it supplies twigs to the superficial perineal muscles. It is accompanied by the posterior scrotal branches of the perineal nerve.

The *transverse perineal artery* is a small vessel which usually springs from the preceding. It pierces the base of the fascia of Colles, and, gaining the surface of the superficial transverse perineal muscle, proceeds medially to the interval between the rectum and the bulb of the urethra, where it ends by supplying the parts in that locality, and by anastomosing with the corresponding vessel of the opposite side.

The *posterior scrotal nerves* are branches of the perineal division of the pudendal nerve. They appear in the anterior part of the ischio-rectal fossa after piercing the obturator fascia. Then they pierce the base of the fascia of Colles and pass forwards in the superficial pouch to the scrotum.

The *long perineal branch of the posterior cutaneous nerve of the thigh* (O.T. *long pudendal nerve*) pierces the deep fascia of the thigh a short distance in front of the ischial tuberosity, and about an inch and a half to the lateral side of the margin of the pubic arch. As it proceeds forwards it inclines medially, and, piercing the attachment of Colles' fascia to the margin of the pubic arch, it accompanies the other vessels and nerves to the scrotum, the lateral and anterior part of which it supplies.

After the superficial vessels and nerves, which lie in the perineal pouch on each side, have been examined, the dissector must proceed to display the other contents of the superficial pouch, viz.—the three parts of the root of the penis; they are the bulb of the urethra, which lies in the median plane, and the right and left crura of the penis, which are attached to the corresponding borders of the pubic arch; the bulbo-cavernosus muscle which covers the bulb of the urethra, the ischio-cavernosus muscles which cover the crura of the penis, and the superficial transverse muscles of the perineum which lie parallel with the base of the superficial pouch. When those structures have been studied he must seek, on each side, the dorsal nerve of the penis, the terminations of the deep branch of the perineal nerve, and three branches of the internal pudendal artery, viz., the artery of the bulb, the dorsal artery of the penis, and the deep artery of the penis.

The bulb of the urethra causes the projecting rounded eminence which occupies the median part of the superficial perineal pouch. It is covered by the bulbo-cavernosus muscle. Each crus penis lies along the corresponding lateral margin of the superficial pouch, and it is covered by the ischio-cavernosus muscle. The superficial transverse muscle passes forwards and medially from the posterior end of the crus penis to the central point of the perineum, which lies immediately behind the posterior end of the bulb of the urethra.

Dissection.—Divide the scrotal nerves and the accompanying arteries near their terminal extremities and turn them aside; then, with the handle of the scalpel, enlarge the interval between the bulb of the urethra, covered by the bulbo-cavernosus, medially, the crus of the penis, covered by the ischio-cavernosus, laterally, and the superficial transverse muscle posteriorly. The membrane which forms the deep boundary of the triangular area thus displayed is the inferior fascia of the urogenital diaphragm.

Only the lower part of the diaphragm is obvious at this stage of the dissection, but the dissector must consider the structure and the general positions and relations of the diaphragm before proceeding further with the dissection.

Urogenital Diaphragm.—Only the superficial surface of the inferior fascia of the urogenital diaphragm is as yet exposed, but it is necessary, before the dissection is carried further and the diaphragm is partially destroyed, that the dissectors should have a general knowledge of its various parts, so that they may understand the relations of the diaphragm to the other structures which lie in the anterior part of the perineum. The *urogenital diaphragm* is a strong, triangular partition which stretches across the pubic arch and separates the anterior part of the perineum from the pelvis. It consists of the deep transverse muscle of the perineum, and the sphincter urethræ membranaceæ, enclosed between two layers of fascia, an upper and a lower. The two layers of fascia are blended together anteriorly and posteriorly. They are attached laterally to the margins of the pubic arch, and they enclose between them a space which contains not only the muscular part of the diaphragm but also the membranous portion of the urethra, the bulbo-urethral glands (O.T. Cowper's), the terminal parts of the internal pudendal vessels and some of their branches, and the dorsal nerves of the penis. The blended *anterior* margins of the *inferior fascia of the urogenital* *diaphragm* (O.T. superficial layer of the triangular ligament), and *superior fascia of the urogenital diaphragm* (O.T. deep layer of the triangular ligament) form the *transverse ligament of the pelvis*, and their blended *posterior* margins form the base of the urogenital diaphragm.

The space between the two fasciæ of the urogenital diaphragm is spoken of as the deep pouch of the urethral triangle of the perineum, in contradistinction to the superficial pouch which lies between the inferior fascia of the diaphragm and the fascia of Colles and has already been examined.

The deep pouch of the urethral triangle contains the deep transverse muscle of the perineum and the sphincter muscle of the membranous urethra, which constitute the muscular portion of the urogenital diaphragm; the membranous part of the urethra; the bulbo-urethral glands; the internal pudendal arteries; their branches to the bulb of the urethra and their terminal branches—the dorsal arteries of the penis and the profunda arteries of the penis; the terminal branches of the deep division of the perineal nerve and the dorsal nerve of the penis.

The membranous part of the urethra enters the deep pouch by piercing the superior fascia of the urogenital diaphragm and leaves it by piercing the inferior fascia. It is accompanied at its exit by the ducts of the bulbo-urethral glands. Each internal pudendal artery and each dorsal nerve of the penis enters the posterior part of the deep pouch at the anterior end of the canal in the obturator fascia. The terminal branches which the internal pudendal artery gives off in the deep pouch leave the pouch by piercing the inferior fascia of the urogenital diaphragm. The dorsal nerve of the penis accompanies the dorsal artery of the penis, which is one of the terminal branches of the internal pudendal artery.

Dissection.—Follow the constituent parts of the root of the penis forwards until they blend to form the body of the penis. Note (1) that the bulb of the urethra diminishes in size as it passes forwards to the under surface of the body of the penis where it forms the middle part of the corpus cavernosum urethræ, the bulb of the urethra being the posterior part and the glans penis the anterior part of that structure. (2) That immediately below the apex of the pubic arch the crura of the penis blend together on the dorsum of the penis to form the corpus cavernosum penis, which constitutes the large dorsal part of the body of the penis.

After the constituent parts of the root of the penis have been fully defined, clean, on each side, the ischio-cavernosus muscle which covers the superficial surface of the crus penis. Follow it backwards to its origin from the medial aspect of the posterior portion of the ramus of the ischium. Then clean the superficial transverse muscle, which springs from the same point, and follow it to its insertion into the central point of the perineum. Next clean the bulbo-cavernosus muscle. Note that it springs from the central point of the perineum and from a fibrous raphe on the superficial surface of the bulb of the urethra. Trace its posterior fibres round the sides of the bulb to the superficial surface of the inferior fascia of the urogenital diaphragm to which they are attached. Note (1) that the middle fibres pass round the sides of the corpus cavernosum urethræ and blend with the muscle of the opposite side on its dorsal surface, ventral to the anterior ends of the crura penis. (2) That the anterior fibres pass round the sides of the corpus cavernosum penis and blend with their fellows of the opposite side on the dorsum of the penis. The arrangement of the fibres shows quite clearly that when the muscles of the two sides act together they must compress the bulb of the urethra, the corpus cavernosum urethræ and the corpus cavernosum penis.

After the superficial perineal muscles have been examined divide the superficial transverse muscle, turn it aside, and attempt to find the terminal twigs of the deep branch of the perineal nerve which pass deep to the superficial transverse muscle and are distributed to that muscle, to the bulbo- and ischio-cavernosus muscles, and to the bulb of the urethra. Next detach the crus penis from the rami of the pubis and ischium, and the superficial surface of the inferior fascia of the urogenital diaphragm. Commence at its posterior end, pass carefully forwards until the profunda artery of the penis is found piercing the inferior fascia of the urogenital diaphragm and entering the crus. Clean that artery for a short distance, and secure the dorsal artery and dorsal nerve of the penis which pierce the inferior fascia of the urogenital diaphragm close to the profunda artery. Then turn to the bulb of the urethra. Detach the posterior end of the bulb from the central point of the perineum, and turn it carefully forwards until the urethra is found entering it in the median plane, and an artery on each side. The arteries are the arteries to the bulb, from the internal pudendal arteries. Do not injure either the arteries or the urethra, but clean the superficial surface of the inferior fascia of the urogenital diaphragm, and then proceed to the study of the structures exposed.

Superficial Perineal Muscles.—Under this heading are included not only the bulbo-cavernosus and ischio-cavernosus muscles, but also the superficial transverse perineal muscles. The superficial perineal muscles have been seen to lie within the pouch formed by the fascia of Colles and the inferior fascia of the urogenital diaphragm. Each muscle is invested by its own delicate layer of deep fascia.

M. Transversus Perinei Superficialis.—The superficial transverse perineal muscle is a narrow slip of muscular fibres which arises from the medial aspect of the ramus of the ischium close to the tuberosity. It passes medially and unites with the corresponding muscle of the opposite side in the central point of the perineum.

The *central point of the perineum* is a tendinous septum, situated in the middle line of the body, close to the posterior end of the bulb and a short distance in front of the anus. Towards it a number of the perineal muscles converge to obtain attachment. *On each side*, it gives attachment to a superficial transverse perineal muscle; *posteriorly*, to the sphincter ani; *anteriorly*, to the posterior fibres of the bulbo-cavernosus; whilst *superiorly*, the anterior fibres of the levator ani descend to reach it.

M. Bulbo-cavernosus (O.T. Ejaculator Urinæ).—The bulbo-cavernosus muscle is spread over the bulb and posterior part of the corpus cavernosum urethræ. It is composed of two symmetrical halves, and its fibres take origin from the central point of the perineum and from a fibrous median raphe which is prolonged forwards between the two halves of the muscle. The insertion differs according to the point at which the muscle is examined. The *posterior fibres* are attached to the superficial aspect of the inferior fascia of the urogenital diaphragm; the *middle fibres*, constituting the greater part of the muscle, sweep around the corpus cavernosum urethræ, so as to invest it completely, and are inserted into an aponeurosis upon the superior surface of that portion of the penis; lastly, the *anterior fibres* form two long narrow muscular bands which diverge from each other like the limbs of the letter V. They pass forwards, over the sides of the corpus cavernosum penis, and are inserted into an aponeurosis on the dorsum of the penis. Thus the *posterior fibres* partially embrace the bulb; the *middle fibres* embrace the corpus cavernosum urethræ; whilst the *anterior fibres* embrace the body of the penis. The bulbo-cavernosus supports the urethra during micturition, and by its contraction it ejects the last drops of urine or semen from the passage.

M. Ischio-cavernosus (O.T. Erector Penis).—The ischio-cavernosus lies upon the crus penis. It arises by fleshy fibres from the medial aspect of the ramus of the ischium close to the tuberosity, and is inserted, by an aponeurotic expansion, into the lower and lateral surface of the anterior portion of the crus.

Radix Penis.—The root of the penis consists of a middle part, the bulb of the urethra, and right and left lateral parts, the crura of the penis.

The *crura penis* are the posterior segments of the corpus cavernosum penis, which forms the dorsal part of the body of the penis. Each is attached to the rami of the pubis and ischium of the corresponding side, and to the adjacent part of the inferior surface of the inferior fascia of the urogenital diaphragm. Its superficial surface is covered by and gives attachment to the corresponding ischio-cavernosus muscle. The profunda artery of the penis enters the anterior part of its deep surface, and the corresponding vein issues from it at the same point to form one of the venæ comites of the internal pudendal artery.

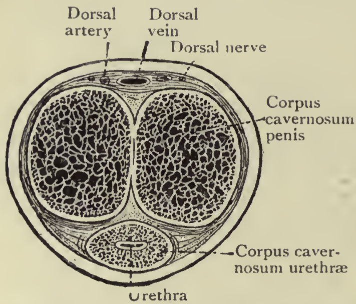


FIG. 79.—Transverse section through the body of the Penis.

The *bulb of the urethra* is the posterior expanded part of the corpus cavernosum urethræ, which lies on the lower surface of the body of the penis, partly embedded in a groove on the inferior aspect of the corpus cavernosum penis. At the anterior end of the penis the corpus cavernosum urethræ enlarges into a cap-like expansion, the glans penis, which covers the anterior end of the corpus cavernosum penis, and posteriorly, in the superficial pouch of the urethral triangle it separates from the corpus cavernosum penis and again enlarges to form the bulb of the urethra which is the middle segment of the root of the penis (Figs. 80, 81, 82).

The *bulb of the urethra* is attached to the inferior surface of the inferior fascia of the urogenital diaphragm by fibrous tissue and by the bulbo-cavernosus muscles. Immediately anterior to its posterior end, the urethra, the ducts of the bulbo-urethral glands, and the arteries to the bulb, one from each internal pudendal artery, enter it, after they have pierced the inferior fascia of the urogenital diaphragm. Occasionally the posterior end of the bulb is divided by a median notch which indicates its bilateral origin.

Nervus Perinei.—The perineal nerve is one of the terminal branches of the pudendal nerve. It arises in the posterior part of the canal in the obturator fascia on the lateral wall of the ischio-rectal fossa, and runs forwards, in the canal, below the internal pudendal artery. At a varying point from its commencement it divides into superficial and deep branches. The superficial branches are the scrotal nerves. They pierce the wall of the fascial canal and enter the

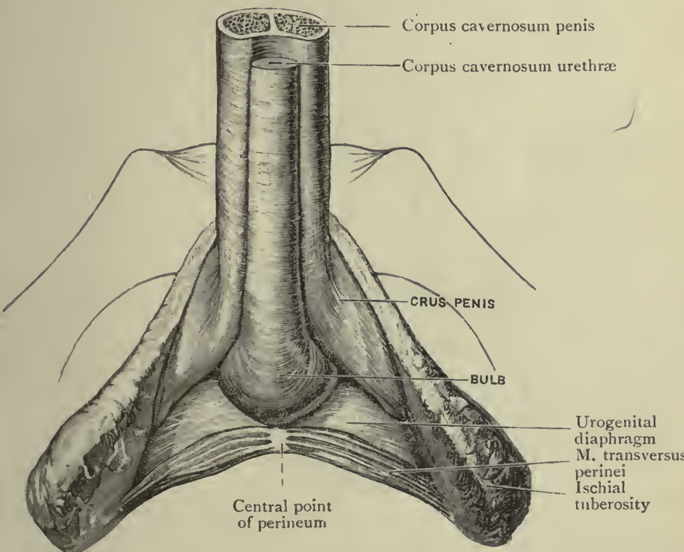


FIG. 80.—The Root of the Penis and the Fascia inferior of the Urogenital Diaphragm (O.T. triangular ligament) (Formalin specimen).

anterior part of the ischio-rectal fossa, then they pierce the base of the fascia of Colles and enter the superficial pouch of the urogenital triangle, there they cross superficial to the superficial transverse muscle of the perineum, and are distributed to the skin of the anterior part of the perineum and to the skin of the scrotum.

The deep branch supplies twigs to the anterior part of the levator ani and the external sphincter ani, then pierces the base of the inferior fascia of the urogenital diaphragm, and enters the superficial pouch, where it supplies the superficial transverse muscle, the bulbo-cavernosus, and the ischio-cavernosus, and it gives a branch to the bulb of the urethra. Some of its branches enter the deep pouch to supply the deep transverse muscle and the sphincter of the membranous urethra.

Inferior Fascia of the Urogenital Diaphragm.—An examination of the inferior fascia of the urogenital diaphragm,

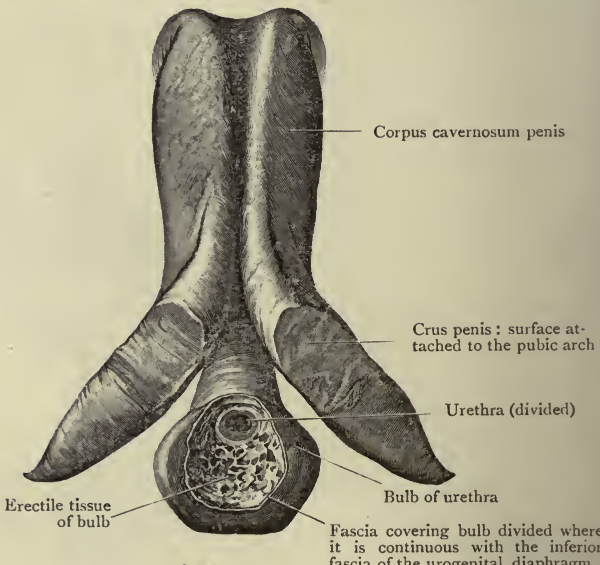


FIG. 81.—Dorsal or attached aspect of the Penis. The specimen was hardened by formalin injection and removed from the pubic arch and the urogenital diaphragm.

which has been considerably exposed by the reflection of the crura of the penis and the turning forward of the posterior part of the bulb of the urethra (see p. 166), will show that it is a strong fibrous membrane which stretches across the pubic arch. It may be regarded as lying in the same morphological plane as the bony and ligamentous wall of the pelvis, and as completing the pelvic wall in front, much in the same manner as the obturator membrane fills up the obturator foramen.

Upon each side the inferior fascia of the urogenital diaphragm is attached to the medial surfaces of the rami of the pubis and ischium. Its base has already been seen to blend, along the posterior border of the superficial transversus perinei muscles, with the fascia of Colles. In addition to that attachment, however, a careful dissection, in a good subject, will show that the central part of the base projects backwards in the form of a short process which joins the central point of the perineum. Near the symphysis pubis the anterior margin, fused with the anterior margin of the superior fascia of the diaphragm, forms the transverse ligament of the pelvis. Between the anterior border of the transverse ligament and the arcuate ligament, which covers the inferior aspect of the symphysis pubis, an oval gap is left for the passage of the dorsal vein of the penis.

In the erect posture of the body the superficial surface of the urogenital diaphragm looks downwards and forwards, whilst its deep surface looks upwards and backwards towards the cavity of the pelvis. In close contact with its inferior fascia are the parts which constitute the root of the penis, viz., the bulb and the two crura, and the muscles which are associated with them, and also the superficial transversus perinei muscle on each side. The structures which lie between its two fasciæ will be studied after the inferior fascia is reflected.

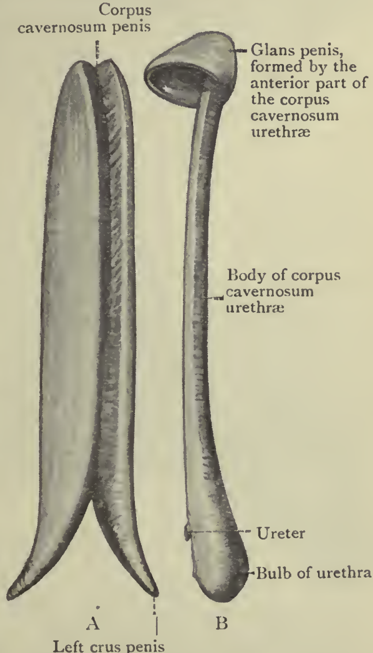


FIG. 82.—Component Parts of Penis.

A. Corpus cavernosum penis and the crura penis, seen from the right and below. Showing the groove for the corpus cavernosum urethræ.

B. Corpus cavernosum urethræ.

The inferior fascia of the urogenital diaphragm is not an unbroken, continuous layer. It is pierced—(1) by the urethra; (2) by the internal pudendal arteries or their terminal branches; (3) by the dorsal nerves of the penis; (4) by the arteries to the bulb; (5) and lastly, at its base, where it blends with the superficial fascia, by the deep branch of the perineal nerve. The *aperture for the urethra* is situated in the middle line, 25 mm. (one inch) below the

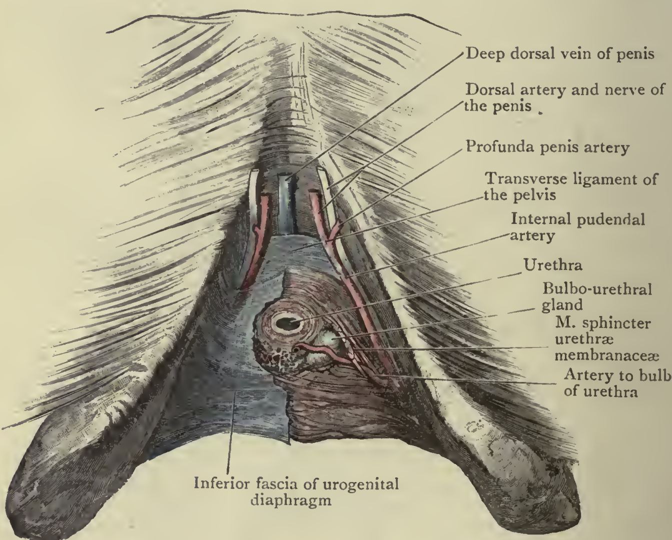


FIG. 83.—Deep dissection of the Perineum. The penis has been removed, the urethra cut across, and the inferior fascia of the urogenital diaphragm removed on the left side.

symphysis pubis. It is not a clean-cut hole with sharp edges. The margins of the opening, which are separated by a considerable interval from the circumference of the urethra, are prolonged over the bulb of the urethra so as to form for it a fibrous capsule. As soon as the urethra gains the superficial aspect of the fascia it sinks into the bulb, and is carried forwards, through the entire length of the corpus cavernosum urethræ, to its external opening on the glans penis. On each side of the urethral aperture there is a small opening in the fascia which gives passage to the corresponding *artery to the bulb.* Half an inch farther forwards the *dorsal nerve of the penis* and the *internal pudendal artery* or its two terminal branches pierce the fascia on each side, close to the margin of the pubic arch, and under cover of the corresponding crus penis.

The term "*inferior fascia*" of the urogenital diaphragm which is applied to this membrane, implies that there is a deeper fascia to be studied in connection with it. But whilst the two fasciæ are very intimately connected, they must be looked upon as being distinct structures. The inferior fascia of the urogenital diaphragm is in the same morphological plane as the bony wall of the pelvis and the obturator membrane, and, in fact, completes the pelvic wall in front. The *superior fascia of the urogenital diaphragm* is merely the parietal layer of the pelvic fascia carried round to the front of the pelvis. Consequently the connections of the latter layer can be examined very much better in conjunction with the pelvic fascia. It should now be noted—(1) that the two fasciæ enclose the urogenital diaphragm; (2) that the anterior and posterior margins of the two layers are blended together; (3) that the interval between the two is closed laterally by the attachment of both layers to the margins of the pubic arch; and (4) that the space between the two layers contains:—

1. The membranous portion of the urethra and its sphincter muscle.
2. The deep transverse perineal muscle.
3. The bulbo-urethral (Cowper's) glands.
4. The internal pudendal vessels, the dorsal nerves of the penis, and the arteries to the bulb.

Dissection.—To expose these parts, on one side, reflect the inferior fascia of the urogenital diaphragm on that side, but carefully preserve the fascia on the opposite side, so that it may serve as a landmark in the subsequent dissection of the pelvis. On the side selected detach the fascia from the pubic arch, and, cautiously raising it from the subjacent structures, throw it medially towards the bulb.

As soon as the inferior fascia of the diaphragm is raised the muscles of the diaphragm come into view. They are small and difficult to dissect, therefore great care must be exercised as an attempt is made to clean them and to define their limits. Commence with the deep transverse muscle, which lies parallel with the base of the inferior fascia. Its posterior border is not difficult to define. Its anterior border blends with the sphincter muscle of the membranous urethra, which occupies the anterior part of the deep pouch. Clean the superficial surfaces of both muscles.

M. Transversus Perinei Profundus et M. Sphincter Urethræ Membranaceæ (O.T. Compressor Urethræ Muscle).—The deep transverse muscle of the perineum is a small fan-shaped muscle which lies between the fasciæ of the urogenital diaphragm. It has a tendinous origin from the margin of the pubic arch at the junction of the pubic and ischial rami. Expanding as it passes medially, it unites with its fellow of the opposite side in a median raphe, below and behind the membranous part of the urethra. Its posterior border lies in the angle between the inferior and superior fasciæ of the urogenital diaphragm, and its anterior border is blended with the external layer of the sphincter muscle of the membranous urethra. The *sphincter of the membranous urethra* consists of internal and external groups of fibres. The internal group is formed of circular fibres which embrace the urethra; they are continuous above with the muscular fibres of the prostate and below with the circular muscular fibres around the posterior part of the cavernous portion of the urethra. The external layer consists of transverse fibres which arise, together with the deep transverse muscle of the perineum, from the margin of the pubic arch and from the inferior fascia of the urogenital diaphragm. As they approach the median plane some of the fibres pass anterior and some posterior to the membranous part of the urethra, and they blend with the corresponding fibres of the opposite side. Both muscles are supplied by one or two delicate twigs from the *perineal division* of the *pudendal nerve.*

Dissection.—Clean the internal pudendal artery, following it forwards, from the point where it enters the postero-lateral angle of the deep pouch (Fig. 83) to its terminal division into the dorsal and profunda arteries of the penis. At the same time clean the dorsal nerve of the penis which lies lateral to the internal pudendal artery. Next secure the branch from the internal pudendal artery to the bulb of the urethra, and follow it medially through the fibres of the deep transverse muscle. As the artery approaches the bulb look for the bulbo-urethral gland, which lies a little posterior and lateral to the urethra, under cover of the posterior fibres of the deep transverse muscle. The staff, introduced at the commencement of the work, is still in the urethra, therefore the position of the membranous part of that canal is easily defined by pressing the tip of the index finger against the staff as it lies in the deep pouch of the urogenital triangle.

Art. Pudenda Interna (O.T. Internal Pudic).—The internal pudendal artery is a branch of the hypogastric. It is met with in three different regions of the body—viz., (1) within the cavity of the pelvis; (2) in the gluteal region, where it lies upon the spine of the ischium; and (3) in the perineal space. It is consequently described as consisting of a *pelvic*, a *gluteal*, and a *perineal part*. The *perineal* or *third part* of the pudendal artery enters the perineum by passing through the lesser sciatic foramen. At first it is placed deeply; but it becomes more superficial as it passes forwards, and, at the same time, it inclines medially, so that, at its termination, it is not far from the middle line of the body.

In the rectal triangle the pudendal artery is contained in the canal in the obturator fascia, on the lateral wall of the ischio-rectal fossa. There it lies fully 38 mm. (an inch and a half) above the level of the lowest part of the ischial tuberosity, and is accompanied by two veins and the two divisions of the pudendal nerve. Of the latter the dorsal nerve of the penis lies above it and the perineal nerve below it. Reaching the base of the urogenital triangle, the pudendal artery insinuates itself between the two fasciæ of the urogenital diaphragm, and, gradually emerging from under cover of the bone, proceeds forwards along the edge of the pubic arch to a point about half an inch below the symphysis; there it pierces the inferior fascia of the urogenital diaphragm, and immediately ends, under cover of the crus penis, by dividing into two branches, viz.—(1) the profunda penis artery, which supplies the corpus cavernosum penis, and (2) the dorsal artery of the penis (Fig. 83, p. 172). In not a few cases it divides while still between the two fasciæ of the urogenital diaphragm, and its two terminal branches pierce the inferior fascia of the diaphragm separately.

Branches of the Internal Pudendal Artery.—The pudendal artery has already been seen to give off the *inferior hæmorrhoidal*, and the *perineal arteries*, and to divide into its two terminal branches—the *dorsal artery of the penis* and the *deep artery of the penis*. Between the fasciæ of the urogenital diaphragm it gives origin to the *artery to the bulb*.

The *artery to the bulb* is a short, wide vessel which springs from the internal pudendal artery about 5 mm. (one-fifth of an inch) above the level of the base of the urogenital diaphragm. It passes medially, between the two fasciæ of the diaphragm, and, giving a small twig to the bulbo-urethral gland, it enters the substance of the bulb. It supplies the corpus cavernosum urethræ with blood (Figs. 83, 110).

The *deep artery of the penis*, immediately after its origin, pierces the medial aspect of the crus penis, and is carried forwards in the substance of the corpus cavernosum penis, which it supplies with blood (Figs. 102, 110).

The *dorsal artery of the penis* runs forwards in the interval between the crura penis, and, passing between the two layers

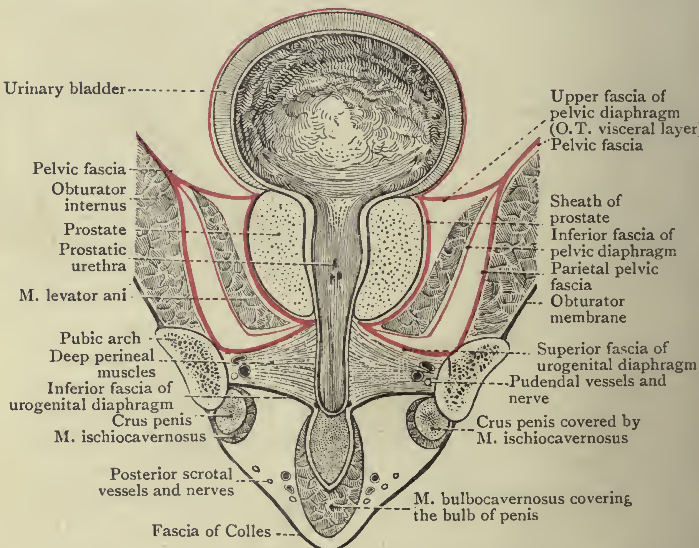


FIG. 84.—Vertical section (schematic) through the pubic arch to show the two perineal compartments

of the suspensory ligament of the penis, gains the dorsum of the penis, where it will be afterwards traced (Fig. 102).

N. Pudendus (O.T. Pudic Nerve).—The pudendal nerve is a branch of the sacral plexus. Following the internal pudendal artery it enters the canal in the obturator fascia, and, after giving off the *inferior hæmorrhoidal nerve*, it divides into two terminal divisions, viz.—(1) the perineal nerve, and (2) the dorsal nerve of the penis.

The *perineal nerve* has been seen to break up into the following branches:—

Cutaneous.	Posterior scrotal.
Muscular.	1. Nerve to the bulbo-cavernosus. 2. Nerve to the ischio-cavernosus. 3. Nerve to the transversus perinei superficialis. 4. Nerve to the transversus perinei profundus. 5. Nerve to the sphincter urethræ membranaceæ.
	Nerves to the bulb of the urethra.

It supplies also one or two branches to the bulb and the corpus cavernosum urethræ.

The *dorsal nerve of the penis* follows the pudendal artery between the two fasciæ of the urogenital diaphragm, where it lies more completely under shelter of the side of the pubic arch than the artery. Finally, piercing the inferior fascia of the diaphragm, about half an inch below the symphysis pubis, it accompanies the dorsal artery of the penis. At the root of the penis it supplies one or two twigs to the corpus cavernosum penis.

Glandulæ Bulbo-urethrales (O.T. Cowper's Glands).—As a general rule, the bulbo-urethral glands can readily be detected by raising the posterior fibres of the deep transverse perineal muscles. They are small lobulated bodies of a deep yellow colour, and resemble peas, both in size and in shape. They are placed, one on each side of the middle line, immediately below the membranous part of the urethra, and are overlapped by the posterior part of the bulb—separated from it, however, by the inferior fascia of the urogenital diaphragm. Each gland has a very delicate and relatively long duct which is difficult to find. The duct does not open into the membranous part of the urethra, but passes forwards at the side of the urethra, through the inferior fascia of the urogenital diaphragm, to open into the floor of the penile part of the urethra 25 mm. (one inch) beyond the diaphragm (Figs. 200 and 203).

Pars Membranacea Urethræ (Membranous Portion of the Urethra).—The canal of the urethra is subdivided for descriptive purposes into three parts, according to the structures which are in relation to its walls, as it passes from the bladder to its termination on the glans penis. These are—(1) the prostatic portion; (2) the membranous portion; and (3) the cavernous portion. Each of the subdivisions has a very definite relation to the urogenital diaphragm; the prostatic part is placed *above and posterior to* both fasciæ of the diaphragm; the membranous part is situated *between* the two fasciæ; whilst the cavernous portion lies *anterior and inferior to* the diaphragm (Fig. 85).

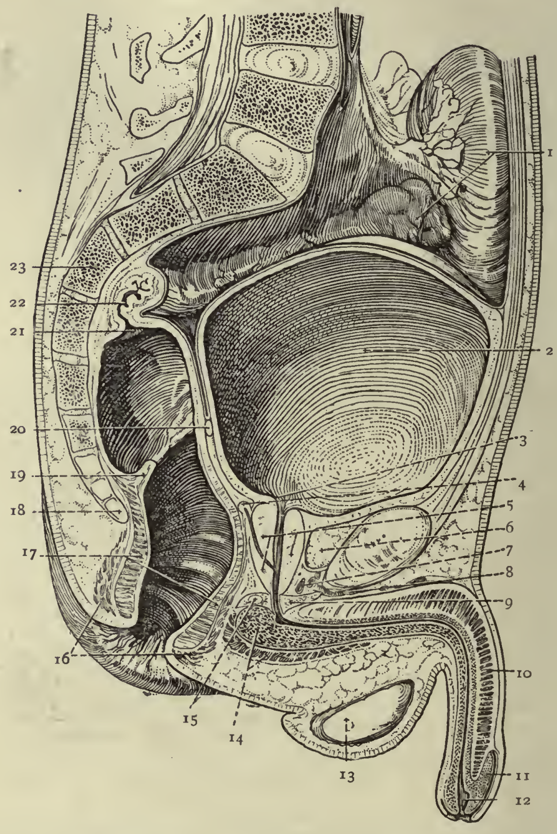


FIG. 85.—Sagittal section of the Pelvis of a young Male Adult with distended Bladder and Rectum.

1. Pelvic colon.
2. Urinary bladder.
3. Uvula of bladder.
4. Seminal vesicle.
5. Prostate.
6. Retro-pubic fat.
7. Pudendal plexus of veins.
8. Dorsal vein of penis.
9. Sphincter urethræ around membranous part of urethra.
10. Corpus cavernosum penis.
11. Glans penis.
12. Fossa navicularis of urethra.
13. Testis.
14. Bulb of the urethra and bulbo-cavernosus muscle.
15. Bulbo-urethral gland.
16. External sphincter.
17. Internal sphincter.
18. 4th piece of coccyx.
19. 2nd transverse rectal fold.
20. Ductus deferens.
21. 1st transverse rectal fold.
22. Commencement of rectum.
23. 3rd sacral vertebra.

Now that the inferior fascia of the diaphragm is removed upon one side, the student can, with the point of the finger, readily feel the staff as it lies within the membranous portion of the urethra. He should examine the surroundings of that canal. It is the shortest subdivision of the urethra, and is about one inch distant from the symphysis pubis. Throughout its entire extent it is enveloped by the fibres of the sphincter muscle, and on that account it is sometimes

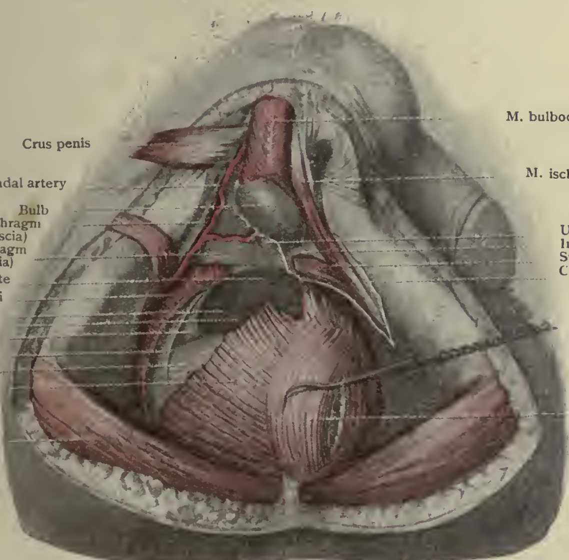


FIG. 86.—Dissection to expose the Prostate from the Perineum.

called the muscular part of the urethra. On each side, and at a lower level, is a bulbo-urethral (Cowper's) gland, whilst between it and the symphysis pubis is the dorsal vein of the penis, which is separated from it by the transverse ligament of the pelvis.

Vasa Lymphatica Perinei.—The lymph vessels of the perineum cannot be displayed in an ordinary dissection, but they are present in great numbers, and the dissectors should remember that the greater part of the lymph from the perineal region is eventually discharged into the proximal group of superficial subinguinal lymph glands which lie in the fat in the upper part of the front of the thigh. It is the enlargement of these glands, therefore, which frequently gives the first intimation of the spread of microbic infection and the migration of the cells of malignant growths from the tissues and organs of the perineal region. They receive lymph from the whole of the skin, the fasciæ, and the muscles of the perineum, and also from the skin of the scrotum, penis, and pubis. They also receive lymph from the body and root of the penis, from the penile part of the urethra, and from the terminal part of the anal canal.

The dissection of the perineum, to the extent usually possible in three days, is now completed, and the student should notice that in the urethral triangle he has opened two fascia-bounded compartments. The superficial compartment lies between Colles' fascia and the urogenital diaphragm. Posteriorly this is closed by the union of the fascia and the diaphragm. Laterally it is closed by the attachment of the fascia and the diaphragm to the rami of the ischium and pubis. Anteriorly, since the fascia of Colles is continuous with the deep layer of the superficial fascia of the abdominal wall, the pouch is open, and fluid poured out into it can pass upwards to the abdominal wall. For the contents of the pouch see p. 154. The deep pouch lies between the two fasciæ of the urogenital diaphragm. It is closed posteriorly and anteriorly by the fusion of the posterior and anterior margins of the two fasciæ, and laterally by the attachment of the two fasciæ of the diaphragm to the rami of the pubis and ischium. For the contents of the deep compartment see p. 165. Above the superior wall of the deep compartment lie the apex of the prostate gland and the anterior borders of the levatores ani muscles. To approach the prostate, therefore, through the urethral triangle, a series of alternating fascial and muscular strata would have to be divided, viz.—

1. The fascia of Colles.
2. The superficial perineal muscles.
3. The inferior fascia of the urogenital diaphragm.
4. The deep transverse perineal muscle and the sphincter of the membranous urethra.
5. The superior fascia of the urogenital diaphragm.

This, however, is not a practicable way of approaching the prostate, and the method which should be adopted to display the posterior surface of the gland will be described when the investigation of the pelvic fascia is undertaken (see p. 418).

A pad of tow, soaked in preservative mixture, should be placed in the perineum, and the flaps of skin carefully stitched over it. On the *fourth day* after the body has been brought into the dissecting-room, it is placed upon its back, and the dissectors of the abdomen commence work upon the abdominal wall, p. 197.

FEMALE PERINEUM.

The boundaries of the female perineum are identical with those in the male (p. 147). The region is wider, however, and of greater extent. For purposes of description it is subdivided, by an imaginary transverse line drawn in front of the anus and the tuberosities of the ischia, into a *posterior*, *anal triangle*, and an *anterior*, *urogenital triangle*.

External Anatomy.—The anal triangle presents the same points for consideration as in the male. The external anatomy of the urogenital triangle demands careful study, because it includes the urethral opening and the external organs of generation. The latter are—

1. The mons pubis.	4. The clitoris.
2. The labia majora.	5. The urethral opening.
3. The labia minora.	6. The vaginal orifice.

All the parts mentioned are included under the common term of *pudendum muliebre* or *Vulva*.

Mons Pubis (O.T. Mons Veneris).—The mons pubis is a marked cushion-like eminence situated in front of the pubes. The projection is due to a collection of adipose tissue under the integument. It is covered with hair.

Labia Majora Pudendi.—The labia majora correspond to the two halves of the scrotum, separated from one another by a median cleft. They are two rounded folds, which commence anteriorly at the mons pubis, where they meet in the *anterior commissure*. From the anterior commissure they extend downwards and backwards towards the anus. As they proceed backwards they diminish in thickness, and they meet posteriorly in the *posterior commissure*. Laterally they are covered by skin studded with scattered hairs, whilst medially they are coated with smooth humid integument, the free surface of which is lubricated by a semi-solid secretion, derived from numerous sebaceous glands which open upon it. During parturition the labia majora are unfolded, and thus give the vagina a greater capability of dilatation.

FIG. 87.—Outlet of Female Pelvis.

The labia majora enclose an elliptical fissure, which is termed the *rima pudendi*, or the *urogenital fissure*, on account of its containing the apertures of the urethra and vagina.

Labia Minora Pudendi.—The labia minora are two pendulous folds of integument which lie between the labia majora. They represent the prepuce and part of the ventral portion of the penis of the male. To display them fully the labia majora must be pulled apart; then they will be seen, placed one on each side of the vaginal orifice. As they pass forwards they become more prominent, and at the same time converge towards one another. When they reach the clitoris, each terminates by splitting into two divisions or folds. The smaller and lower folds are attached to the inferior surface of the clitoris, where they form the *frenulum clitoridis*. The upper fold arches over the clitoris like a hood, and unites with the corresponding fold of the opposite side to form the *præputium clitoridis*.

A short distance in front of the posterior commissure the posterior extremities of the labia minora are usually connected together by a transverse fold, the *frenulum labiorum pudendi*, and immediately anterior to and above that fold, between it and the posterior border of the orifice of the vagina, is a depression, the *fossa navicularis*.

The frenulum pudendi may be absent, and if present it is usually ruptured during the first labour.

It may be well for the student to bear in mind that the term "perineum" is used by obstetric surgeons in a very restricted sense. It is applied by

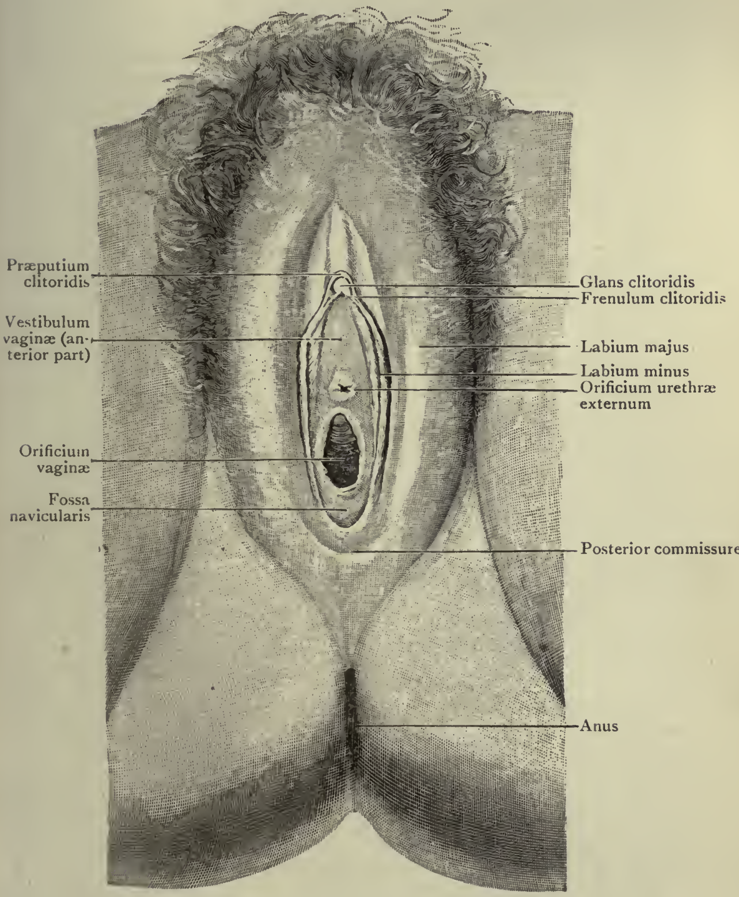


Fig. 88.—Female External Genital Organs.

The frenulum labiorum pudendi is seen stretching across behind the fossa navicularis and in front of the posterior commissure. The ducts of the greater vestibular glands open in the intervals between the vaginal orifice and the medial edges of the labia minora. (Dixon.)

them to the small region between the anus and the frenulum labiorum pudendi.

Clitoris.—The clitoris is the homologue of the penis, and, notwithstanding its diminutive proportions, it presents a close resemblance to the male organ both in appearance and structure. It is a minute elongated projection placed behind the anterior commissure, and surmounted by a sensitive rounded tubercle called the *glans*; but it is not traversed by the urethra. The manner in which its prepuce and frenulum are formed has already been described. To obtain a proper view of the clitoris the dissectors must lay hold of the glans with the forceps and draw it out from the prepuce.

Vestibule.—The term vestibule is applied to the region which lies between the labia minora and extends from the clitoris in front to the frenulum labiorum pudendi behind. When the labia minora are pulled apart it appears as a triangular interval. The vagina, the urethra, and the ducts of the greater vestibular glands open into it. The vagina opens into the posterior part from above. The urethral opening is directly in front of the vaginal opening in the median plane. The duct of the corresponding larger vestibular gland opens, on each side, in the angle between the vaginal orifice and the labium minus. In front of the orifice of the urethra, when the labia minora are pulled apart, there is a smooth triangular piece of mucous membrane which forms the upper boundary of the anterior part of the vestibule between the opening of the urethra and the clitoris. The vestibule opens below into the cleft between the labia majora (Fig. 226).

Orificium Urethræ.—The orifice of the urethra lies close to the opening of the vagina, about 25 mm. (one inch) behind the clitoris. It usually presents the appearance of a vertical slit, and the mucous membrane around it is prominent, pouting, and slightly puckered, so that when the tip of the finger is passed over the roof of the anterior part of the vestibule the opening can readily be distinguished by touch.

Orificium Vaginæ.—The vaginal orifice, in the virgin, is partially closed by the *hymen*—formed by two semilunar folds of mucous membrane attached to the sides of the entrance to the vagina, and united together anteriorly and posteriorly. The form of the hymen, however, is very variable. Sometimes it is present in the shape of a septum attached around the entire circumference of the vaginal entrance, but pierced in the centre by a circular opening or an antero-posterior slit; again, it may be cribriform, or fringed along its free margin. Lastly, it may constitute a complete septum across the opening of the vaginal canal. In that case awkward results ensue from the retention of the menstrual fluid. After it has been ruptured its position is marked by certain rounded elevations which have received the name of *carunculæ hymenales.*

Close to each side of the vaginal orifice, in the groove between it and the posterior part of the labium minus, is the opening of the duct of the *greater vestibular (Bartholin's) gland*, an orifice just visible to the naked eye.

Passage of Catheter and Examination of Orificium Externum Uteri.—The dissector should now practise the passing of the female catheter, and afterwards introduce a speculum into the vagina, to obtain a view of the orificium externum uteri.

Before the catheter is passed, the forefinger of the left hand should be placed in the orifice of the vagina, with its palmar surface directed upwards towards the pubes. If the instrument is now directed along this finger and the point raised slightly, when it reaches the entrance to the vagina, a little manipulation will cause it to enter the urethra.

When the speculum is introduced into the vagina, the points to be noted in connection with the external orifice of the uterus are:—(1) the small size of the opening; (2) the two rounded and thick lips which bound the aperture. Both in the virgin and in women who have borne children it is a transverse cleft, but in the former it is small and its anterior and posterior lips are smooth and rounded, whilst in the latter it is usually larger and its lips are frequently cleft and scarred. Note, further, that the anterior lip is the thicker and shorter of the two.

***Dissection.*—Reflection of Skin.**—The anal canal should be slightly filled with tow, and the anal orifice stitched up, then the margins of the labia minora should be stitched together.—Incisions—(1) A transverse incision should, in the first place, be carried from one ischial tuberosity to the other, in front of the anus. (2) The urogenital fissure and the orifice of the anus should next be closely encircled by incisions, and these joined by a cut along the median plane. (3) Lastly, carry an incision forwards from the second or third piece of the coccyx along the median plane to the cut which surrounds the anus.

Four flaps are thus marked out; the two anterior may be thrown forwards and laterally, and the two posterior backwards and laterally.

Panniculus Adiposus (Superficial Fascia).—The superficial fascia of the perineum is now laid bare. In the anal triangle it agrees in every particular with the same portion of fascia in the male (p. 151). In the anterior or urogenital triangle, however, owing to the difference in the external organs of generation, there is a slight modification. It presents the same two layers. In the superficial fatty layer, where it covers the labia majora, there are *dartos fibres* similar to those in the scrotum of the male. The deeper layer has the same attachments as in the male, viz., to the margins of the pubic arch, and to the base of the urogenital diaphragm ; but it is not so membranous, and consequently does not form so distinct a stratum. The two superficial fascial pouches are also present in the female, and are sometimes spoken of as the *vulvo-scrotal sacs.* Their separation along the median plane is not due to the interposition of a median septum, as in the male, but to the presence of the urogenital fissure. They are not so easily demonstrated as in the male, but an attempt should be made to investigate them.

Dissection.—Cut through the fatty layer of the superficial fascia of the urogenital triangle until the deeper membranous layer (Colles' fascia) is exposed. Make a small longitudinal incision through Colles' fascia and introduce the tip of the little finger through it, then attempt to pass the finger medially, laterally, backwards, upwards, and forwards. Medially its passage beyond the median plane is prevented by the wall of the urogenital cleft. Laterally, it cannot be passed into the medial part of the thigh because Colles' fascia is attached to the margins of the rami of the pubis and ischium. It cannot pass backwards, beyond the anterior boundary of the anal triangle, because there Colles' fascia unites with the base of the fascia of the urogenital diaphragm. Upward pressure, towards the pelvis, will demonstrate the presence of the strong inferior fascia of the urogenital diaphragm which forms the upper boundary of the superficial pouch of the urogenital triangle on each side, and prevents the finger passing upwards into the pelvis ; but when the tip of the finger is directed forwards it will be found that it can be passed in front of the apex of the pubic arch and then upwards in front of the symphysis to the region of the anterior wall of the abdomen. As the finger lies in front of the symphysis it can be passed across to the opposite side of the median plane, but it cannot be passed laterally into the thigh because the deep layer of the superficial fascia is attached to the front of the body of the pubis.

The dissector who has followed the above instructions, successfully, will have demonstrated the presence of the superficial pouch of the urogenital triangle in the female and its division into right and left parts by the urogenital cleft. In the male the pouch is less completely divided than in the female; the boundaries of its anterior part are enlarged to form the scrotum in which the male genital glands (the testes) are lodged, and it is of special interest in relation with the extravasation of urine from a ruptured urethra. In the female each half of the pouch lies in the corresponding labium majus. Extravasation of urine into it does not occur, but it is of interest in association with the fact that occasionally the female genital gland (the ovary) descends into it instead of remaining in the pelvis. The descent of the ovary into the superficial pouch of the urogenital triangle is abnormal, but its occurrence should be remembered in order that mistakes of diagnosis may be avoided.

Anal Triangle.

Nothing need be added to what has already been written regarding this portion of the perineal space in the male. In both sexes the steps of the dissection and the parts found are precisely the same (*vide* p. 155).

Urogenital Triangle.

Superficial Perineal Vessels and Nerves. — Under this heading are included :—

Arteries. { The superficial perineal artery.
The transverse perineal artery.

Nerves. { The posterior labial nerves.
The long perineal branch of the posterior cutaneous nerve of the thigh.

The vessels and nerves mentioned lie, as in the male, in the superficial pouch of the urogenital triangle, but they are smaller than the corresponding structures in the male and are distributed to the labia majora instead of to the scrotum.

Dissection.—The superficial or posterior labial branches of the perineal nerve have already been secured in the antero-lateral angle of the ischio-rectal fossa (see p. 158). Now follow them forwards into the superficial pouch of the urogenital area. They are accompanied by the superficial branch of the perineal artery which must be cleaned at the same time. As the posterior labial nerves are traced forwards they will be found to be joined, on the lateral side, by the long perineal branch of the posterior cutaneous nerve of the thigh, which pierces Colles' fascia about 25 mm. (one inch) anterior to the tuberosity of the ischium. Secure that nerve and follow it forwards to its termination, but do not interfere with it in the thigh, where it belongs to the dissector of the inferior extremity.

For the detailed description of the vessels and nerves exposed by the above dissection the dissectors must refer to

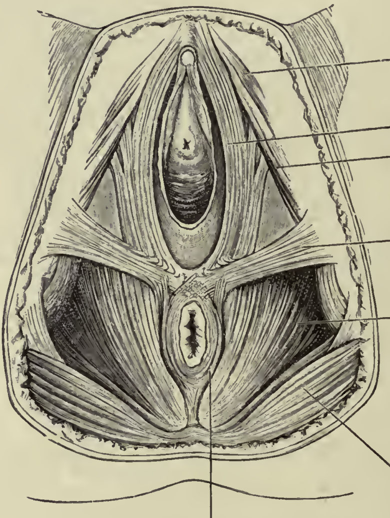


Fig. 89.—Muscles of the Female Perineum (Peter Thompson).

p. 162, where the corresponding structures are described in the male.

Dissection.—Divide the posterior labial nerves and the accompanying vessels near their anterior ends and turn them backwards; then clean the *superficial perineal muscles.* They are, on each side—(1) the ischio-cavernosus, (2) the bulbo-cavernosus, and (3) the superficial transverse muscle. The ischio-cavernosus lies along the pubic arch on the surface of the crus of the clitoris. The bulbo-cavernosus is placed medially on the surface of the bulb of the vestibule which lies along the sides of the vestibule. The superficial transverse muscle runs from the posterior end of the ischio-cavernosus to the central point of the perineum, which lies in the median plane midway between the vaginal and anal orifices.

Whilst cleaning the muscles secure the nerve twigs which are given to them from the deep divisions of the perineal branch of the pudendal nerve.

M. Transversus Perinei Superficialis.—The superficial transverse perineal muscle has the same disposition as in the male, but it is rare to find it so well marked in the female. In most subjects its fibres are pale, and it is generally very difficult to define. It is a slender fasciculus which takes origin from the medial surface of the ramus of the ischium, close to the tuberosity, and passes obliquely medially to its insertion into the central point of the perineum.

In the female the central point of the perineum is between the posterior labial commissure and the anus.

M. Ischio-cavernosus.—The ischio-cavernosus is much smaller than the corresponding muscle in the male. It arises from the medial aspect of the ramus of the ischium close to the tuberosity, and is inserted by a tendinous expansion on the surface of the crus of the clitoris.

M. Bulbo-cavernosus.—The bulbo-cavernosus (O.T. *sphincter vaginæ*) is a true sphincter muscle. It consists of two halves, which are placed one on each side of the vestibule, closely adapted to the surfaces of the two halves of the bulb of the vestibule. Posteriorly the fibres of opposite sides unite behind the vaginal opening, and are attached to the central point of the perineum, some of the fibres intermixing with those of the sphincter ani. Anteriorly the two portions of the muscle become narrower, and, converging towards the middle line, are attached to the sides of the clitoris. In some cases a small fasciculus, on each side, may be observed to reach the dorsum of the clitoris and there gain insertion into a tendinous expansion which lies superficial to the dorsal vein. That fasciculus is comparable to the anterior fibres of the bulbo-cavernosus of the male, which embrace the body of the penis (see p. 167).

On each side of the urogenital area the three superficial muscles of the perineum form the boundaries of a small triangular area. The tip of the index finger should be placed in the triangle and should be pushed upwards towards the pelvis. The resistance which will be met with is caused by the inferior fascia of the urogenital diaphragm, which will be investigated after the contents of the superficial pouch have been examined.

Perineal Body.—It has been already stated that the term "perineum" is confined by the obstetrician to the area between the frenulum pudendi and the anus. At this stage of the dissection it will be obvious that the region in question is occupied by an indefinite mass of fibrous and muscular tissue, which occupies the interval between the anal canal and the vagina. The mass is known as the *perineal body*. Muscular tissue belonging to the sphincter ani, levatores ani, and bulbo-cavernosus, together with the central point of the perineum, enter into its constitution.

> ***Dissection.***—The bulbo-cavernosus should now be carefully raised from the surface of the bulb of the vestibule, and the ischio-cavernosus from the surface of the crus clitoridis. The transversus perinei superficialis may be removed at the same time.

Bulbus Vestibuli.—When the above dissection is completed the bulb of the vestibule is displayed. It consists of two oblong bodies, composed of erectile tissue, placed one on each side of the vestibule and entrance to the vagina. Each half is invested by a fibrous capsule which binds it closely to the inferior surface of the inferior fascia of the urogenital diaphragm. It is relatively broad posteriorly, but narrows as it passes forwards, and in front, between the urethra and the clitoris, the two halves are united by a venous plexus, called the *pars intermedia*, which is itself continuous in front with the glans of the clitoris. The details of the connections mentioned cannot usually be seen in an ordinary dissecting-room part, but they are quite obvious in a specially injected specimen.

The posterior end of each half of the bulb of the vestibule is in contact with and partially overlaps the corresponding larger vestibular gland (Bartolini). The lateral, convex surface is covered by the bulbo-cavernosus muscle and the medial surface is in contact with the wall of the vestibule at its junction with the vagina (Fig. 90).

The arrangement of erectile tissue of the bulb of the vestibule in the female corresponds, more or less closely, with the condition present in the bulb of the urethra in the male. The apparent dissimilarity is due to the presence of the uro-genital fissure and orifice of the vagina. Suppose, for a moment, that the latter was obliterated and that the vestibule was closed to form a canal which carried the urethra forwards to the extremity of the clitoris. The two halves of the bulb would then be in contact with each other, and its entire surface would be covered by a muscular stratum, after the manner of the bulb and bulbo-cavernosus in the male. Further, the urethra would be surrounded by erectile tissue, and the pars intermedia would correspond, to some extent, to that portion of the corpus cavernosum urethræ which, in the male, lies in front of the bulb and becomes continuous with the glans penis.

Dissection.—If the stitches which were used to close the vestibule have not been removed take them away now. Then to display the constitution of the clitoris strip the skin away from the body of the clitoris. Next dissect away the areolar tissue from the body of the clitoris, but do not injure the dorsal vein of the clitoris which lies in the median plane on the dorsal aspect, the dorsal arteries and nerves which lie at the sides of the vein, and the suspensory ligament which attaches the clitoris to the front of the symphysis pubis.

Clitoris.—The *body of the clitoris*, which is about 38 mm. (an inch and a half) long, is bent in a downward direction on itself, at the lower border of the symphysis pubis. It consists of a cylindrical mass of erectile tissue called the *corpus cavernosum clitoridis*, and is homologous with the corpus cavernosum penis. Along the middle line it is partially separated into right and left halves by an imperfect *septum*. Anteriorly it terminates in a small rounded tubercle, which bears the name of the *glans clitoridis*. The glans, however, is not structurally continuous with the corpus cavernosum. It is a little mass of erectile tissue continuous with the pars intermedia, and fitting into a slight concavity which is formed for its reception on the extremity of the corpus cavernosum. Posteriorly, opposite the lower part of the symphysis pubis, the corpus cavernosum separates into two parts, the *crura clitoridis*, which diverge widely from each other. Each crus is attached by its deep surface to the rami of the pubis and ischium, and is covered by the corresponding ischio-cavernosus muscle.

The clitoris, then, consists of three parts:—(1) *a glans* continuous with the pars intermedia; (2) *a body*; and (3) *two crura*, attached to the sides of the pubic arch. It has been noted that the pars intermedia corresponds with part of the corpus cavernosum urethræ in the male. The clitoris in the female, therefore, closely resembles the penis in the male, the chief differences being the diminutive size of the clitoris, and the fact that the glans clitoridis is not perforated by the urethra.

After the bulb of the vestibule and the clitoris have been studied an attempt should be made to expose the larger vestibular gland and the superficial surface of the inferior fascia of the urogenital diaphragm.

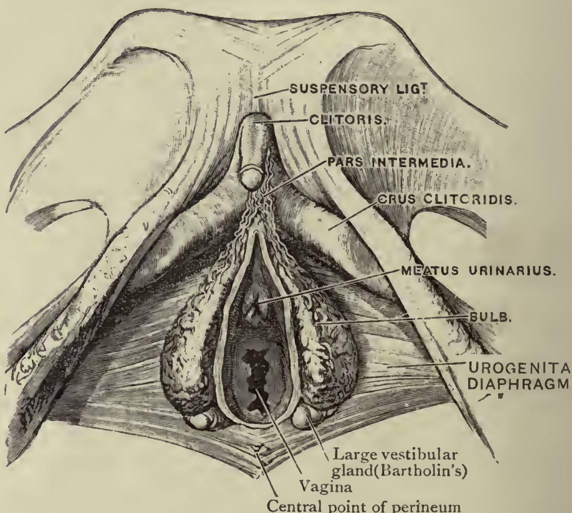


FIG. 90.—Dissection of Female Perineum to show the Clitoris and the Bulb of the Vestibule.

Dissection.—Clear away the areolar tissue at the posterior end of the bulb of the vestibule, and expose the larger vestibular gland. The duct of the gland is long but thin, and is not easily found. It issues from the anterior part of the gland, and the posterior end of the bulb of the vestibule must be raised to expose it. Whilst raising and turning forwards the posterior end of the bulb look for the artery to the bulb, which pierces the inferior fascia of the urogenital diaphragm. After the artery to the bulb has been secured detach the crus of the clitoris from the rami of the ischium and pubis. Commence at the posterior end of the crus and proceed forwards. As the anterior part of the crus is approached the anteria profunda clitoridis will be found entering the deep surface of the crus, and, immediately adjacent to it, the dorsal artery and nerve of the clitoris will be seen passing forwards to the dorsum of the clitoris. Now divide the artery to the bulb of the vestibule, detach the bulb from the

inferior fascia of the urogenital diaphragm and turn it forwards. When the crus of the clitoris and the bulb of the vestibule have both been separated from their attachments and turned forwards the superficial surface of the inferior fascia of the urogenital diaphragm will be exposed.

Glandulæ Vestibulares Majores (O.T. **Bartholin's Glands**).—The greater vestibular glands are the representatives of the bulbo-urethral glands of the male. They are placed one upon each side of the entrance to the vagina, immediately behind the rounded posterior end of the bulb of the vestibule, and under cover of the bulbo-cavernosus. Each is a round or oblong body, about the size of a bean; a long duct proceeds from it, and opens in the angle between the labium minus and the hymen or carunculæ hymenales (Fig. 90, p. 192).

Urogenital Diaphragm.—Owing to the greater width of the pubic arch, the urogenital diaphragm is more extensive in the female than in the male (see Fig. 90). It does not possess the same strength, however, and is not so perfect, seeing that it is pierced by the vaginal canal. As in the male the diaphragm consists of a muscular layer enclosed between a superior and an inferior fascia. The muscular layer consists of the deep transverse perineal muscle and the sphincter of the membranous part of the urethra. The superior and inferior fasciæ are blended in front, a short distance below the arcuate ligament at the apex of the pubic arch, to form the *transverse ligament of the pelvis.* They are blended again behind, along the line of separation between the urogenital and anal triangles, at the base of the urogenital diaphragm, where they fuse also with Colles' fascia. Both the superior and the inferior fascia are attached laterally to the rami of the pubis and ischium; therefore the fasciæ enclose a space, called *the deep pouch of the urogenital triangle.* The pouch is occupied by the muscles of the diaphragm. It is traversed by the vagina, the urethra; the internal pudendal artery, and the dorsal nerve of the clitoris. The antero-posterior and transverse extents of the pouch are considerable, but the distance between the superior and inferior fascia, where they are widest apart, is not more than about 20 mm. (four-fifths of an inch); consequently, as both the vagina and the urethra pass perpendicularly through the diaphragm, they lie for only a short distance in the deep pouch.

The superior fascia of the diaphragm is part of the parietal pelvíc fascia, which lines the inner surface of the pelvic wall; it will be dealt with again when the pelvic fascia is dissected (p. 418). The inferior fascia is on the same morphological plane as the obturator membrane, and like that membrane it partially fills a gap in the bony wall of the pelvis. Its base is fused with the Colles' fascia, and it is pierced by the deep branch of the perineal nerve and by the perineal artery. The posterior labial nerves cross the base of Colles' fascia. Its blunted apex is blended, as already stated, with the superior fascia to form the transverse ligament of the pelvis, and between it and the arcuate ligament of the pubis there is a small space through which the dorsal vein of the clitoris passes backwards to join the vesical plexus. The inferior fascia is pierced, in the median plane, about 27 mm. (a little more than one inch) below the apex of the pubic arch by the vagina, and, immediately in front of the vagina, by the urethra. At each side of the vagina it is pierced by the artery to the corresponding half of the bulb of the vestibule, and, a short distance below the apex, on each side, it is pierced by the dorsal nerve of the clitoris, and either by the terminal part of the internal pudendal artery or by its two end branches, namely, the dorsal and deep arteries of the clitoris.

Dissection.—The inferior fascia of the urogenital diaphragm should be reflected upon one side. Detach it from the margin of the pubic arch and throw it medially; then, if the muscles are in good condition, clean them. After the muscles are cleaned, follow the artery of the bulb, laterally, to its origin from the internal pudendal artery, and then clean the internal pudendal artery from behind forwards to its termination. It lies in the lateral margin of the pouch, close to the pubic arch, and is accompanied by the dorsal nerve of the clitoris, which must also be cleaned. When the dissection is completed, revise the structures which lie in the deep pouch, and reconsider the main points associated with the internal pudendal artery and the pudendal nerve.

M. Transversus Perinei Profundus et M. Sphincter Urethræ Membranaceæ (O.T. Compressor Urethræ Muscle).—The deep transverse muscle of the perineum is even smaller in the female than in the male, and is also less distinctly separable from the sphincter of the membranous part of the urethra. It arises laterally from the margin of the pubic arch, at the junction of the ischial and pubic rami, and it terminates medially on the lower part of the posterior wall of the vagina. Its anterior fibres blend with the posterior fibres of the sphincter of the urethra. The *sphincter* consists of an internal layer of fibres arranged circularly round the urethra, and an external layer which springs from the pubic arch, anterior to the origin of the deep transverse muscle, and from the inferior fascia of the urogenital diaphragm. As the fibres of this layer approach the median plane some pass in front of the vagina and urethra, and others are attached to the posterior wall of the vagina. Both the above muscles are supplied by twigs from the perineal branch of the pudendal nerve.

Arteria Pudenda Interna et Nervus Pudendus.—The internal pudendal artery and the pudendal nerve have a disposition similar to the corresponding artery and nerve in the male (see p. 176), but they are smaller and the names of some of their branches are different, in association with the different names of the parts to which they are distributed; thus the posterior labial branches of the perineal division of the pudendal nerve of the female correspond to the posterior scrotal nerves of the male, and the dorsal nerve of the clitoris corresponds to the dorsal nerve of the penis. Similarly the posterior labial branches of the perineal artery of the female correspond to the posterior scrotal arteries of the male; the artery to the bulb of the vestibule of the female corresponds to the artery to the bulb of the urethra in the male, and the dorsal and deep arteries of the clitoris are homologous with the dorsal and deep arteries of the penis.

Nervus Perinei.—As in the male, the pudendal nerve, as it lies in the posterior part of the canal in the obturator fascia on the lateral wall of the ischio-rectal fossa, gives off its inferior hæmorrhoidal branch, and then divides into two branches, the perineal nerve and the dorsal nerve of the clitoris.

The perineal nerve runs forwards in the canal below the internal pudendal artery, and, near the anterior part of the ischio-rectal fossa, it divides into a superficial and a deep division, both of which pierce the medial wall of the canal and enter the anterior part of the fossa. The superficial division is cutaneous; it divides into the posterior labial nerves which pierce the base of Colles' fascia and run forwards in the superficial pouch of the urogenital triangle to supply the skin of the labia of the corresponding side. The deep branch is mainly muscular. It supplies twigs to the anterior parts of the external sphincter of the anus and the levator ani; then it pierces the base of the fascia of the urogenital diaphragm, and supplies the muscles in the superficial pouch, viz., the bulbo-cavernosus, the ischio-cavernosus, and the superficial transverse muscle. It also supplies the deep transverse muscle and the sphincter of the membranous urethra, and gives a branch to the bulb of the vestibule.

Nervus Dorsalis Clitoridis.—The dorsal nerve of the clitoris runs forwards above the internal pudendal artery, and, with that artery, at the anterior end of the canal in the obturator fascia it insinuates itself between the two fasciæ of the urogenital diaphragm, between which it continues forwards along the margin of the pubic arch. About 12 mm. (half an inch) below the apex of the arch it pierces the inferior fascia of the diaphragm and passes to the dorsum of the clitoris, where it will be followed later. Whilst it is between the two fasciæ it gives a branch to the crus of the clitoris.

Dorsal Vessels and Nerves of the Clitoris.—On the dorsum of the clitoris a little dissection will display the *dorsal vein* occupying the groove in the middle line, with a *dorsal artery* and *nerve* lying upon each side of it.

The arteries and nerves should be traced forwards to their distribution in the glans.

The *dorsal vein of the clitoris* takes origin in the glans. As it proceeds backwards it receives certain superficial veins, and also tributaries from the corpus cavernosum clitoridis. At the root of the clitoris it passes between the transverse ligament of the pelvis and the arcuate ligament of the pubis, and is continued backwards into the pelvis, to join the plexus of veins on the wall of the vagina in the region of the neck of the bladder. It communicates also with the internal pudendal vein.

Urethra Muliebris.—The female urethra is a short canal, about 38 mm. (one and a half inches) in length, which extends from the neck of the bladder to its orifice in the region of the vestibule. It passes downwards and forwards behind the lower half of the symphysis pubis and the pubic arch, but it is slightly curved with concavity forwards.

At first it is situated in the pelvis, separated from the symphysis pubis by a pad of retro-pubic fat; then it pierces the superior fascia of the urogenital diaphragm and enters the deep pouch of the urogenital triangle of the perineum, where it is surrounded by the sphincter muscle of the membranous urethra. It leaves the deep pouch by piercing the inferior fascia of the urogenital diaphragm, and at once opens into the anterior part of the vestibule. Through the whole of its extent it is closely attached to the anterior wall of the vagina.

The dissector should pass a staff through the urethra and trace its course to the bladder by means of the left index finger introduced into the vagina.

After the position of the urethra has been defined, place a pad of tow soaked in preservative solution in the perineum and stitch the skin flaps over it. On the fourth day after the body has been brought into the dissecting room, it is placed upon its back, and the dissectors of the abdomen commence work on the abdominal wall.

THE ABDOMINAL WALL.

After the dissection of the perineum is completed, the body is placed upon its back, with blocks under the thorax and pelvis, and the dissectors of the abdomen begin the dissection of the abdominal wall (Fig. 91).

External Anatomy.—It is well, however, before proceeding to the actual dissection, that some attention should be paid to the general configuration and bony prominences of the region. If the subject is obese the abdomen presents a smooth, rounded, and protuberant appearance; if, on the other hand, it is spare, the abdominal wall is depressed, and the lower margin of the thorax above, and the pubes, the iliac crests, and the inguinal ligaments below, stand out in marked relief. In the median plane the student will notice a linear depression extending downwards, from the lower end of the sternum, towards the symphysis. The depression corresponds with the position of the *linea alba*, which lies, in the median plane, between the two recti muscles.

The linea alba is important to the surgeon, because it is a fibrous portion of the abdominal wall and it is practically devoid of blood-vessels; consequently it is chosen as the region through which the trocar is introduced into the abdomen in the operation of paracentesis abdominis or tapping.

In the linear depression, rather nearer the pubis than the xiphoid process of the sternum, is the *umbilicus* or *navel.* It is a depressed and puckered cicatrix, but its floor is frequently raised to form a little button-like knob. It forms part of the linea alba, and is the result of the closure of the umbilical orifice which existed in the abdominal wall, up to the period of birth, for the passage of the constituents of the umbilical cord, viz.—the allantois, the umbilical vein, and the two umbilical arteries. The dissector should remember that the allantois was connected with the urinary bladder, the umbilical vein with the liver, and the umbilical arteries with the hypogastric arteries. After birth the umbilical cord is severed, and thereafter its constituent parts atrophy. Those portions of them which were situated in the umbilical orifice fuse with the margin of the orifice to form the fibrous cicatrix called the umbilicus, and are no longer recognisable as distinct structures; but the parts which lie within the abdomen are recognisable throughout the whole of life, and will be found enclosed in folds of peritoneum when the abdomen is opened.

In well-developed subjects a rectus abdominis muscle stands out on each side of the median line, forming a longitudinal prominence, which is broader above than below. Its lateral margin, which forms a curved line with the concavity directed medially, corresponds with the *linea semilunaris—i.e.* the line along which the aponeurotic tendon of the internal oblique muscle splits to enclose the rectus abdominis. The linea semilunaris is occasionally selected by the surgeon as the site for incisions through the abdominal wall because of its slight vascularity, but it must not be forgotten that an incision of any length passing through it will necessarily divide one or more of the nerves which supply the rectus abdominis.

The dissector should note that the lateral margin of the rectus abdominis crosses the lower margin of the thorax at the level of the ninth costal cartilage, and the point of crossing, on the right side, indicates the position of the fundus of the gall-bladder.

After the regions of the linea alba and the linea semilunaris have been examined, place the index finger on the upper part of the symphysis pubis, at the lower end of the linea alba, and carry it laterally along the pubic crest to the pubic tubercle. At the pubic tubercle it will enter a linear depression which runs upwards and laterally, at the junction of the abdomen and the thigh, along the line of the inguinal ligament, to the anterior superior spine of the ilium. All the parts mentioned can be felt if careful pressure is made. After they have been identified the dissector should endeavour to determine the position of the subcutaneous inguinal ring (O.T. external abdominal). In the male it is easily defined. Immediately lateral to the pubic tubercle the spermatic cord can be felt as it passes over the medial end of the inguinal ligament on its way to the scrotum. Take the spermatic cord as a guide, push the loose skin of the scrotum upwards along it before the finger, and the tip of the finger will enter the ring, and will be able to distinguish its sharp lower and upper margins. The most important constituent of the spermatic cord is the ductus deferens. If the cord is rolled between the index finger and the thumb, the duct can be easily distinguished, at the back of the cord, by the hard whipcord-like feel that it produces.

The subcutaneous inguinal ring of the female is not easily defined, because it is small, and the round ligament of the uterus, which passes through it, is not readily felt in the fat of the pubic region.

After the inguinal region has been examined, carry the index finger backwards, from the anterior superior spine of the ilium, along the iliac crest. The crest is easily felt; indeed, in most cases it is visible for a distance of about 65 mm. (two and a half inches). At the point where it disappears from view a prominent tubercle is developed on its external lip. It is there, at the highest point of the iliac crest which can be seen from the front, that the lateral outline of the trunk joins the ilium. As will be seen later, use is made of this fact in subdividing the abdominal cavity into regions.

In females who have borne children the skin over the lower part of the abdomen is wrinkled and scarred.

Parts to be dissected. — During the dissection of the abdominal wall the following parts will be displayed :—

1. Superficial fascia.
2. Cutaneous vessels and nerves.
3. The external oblique muscle of the abdomen.
4. The internal oblique muscle of the abdomen.
5. The anterior branches of the lower six thoracic nerves and accompanying vessels; the ilio-inguinal and ilio-hypogastric nerves.
6. The transversus abdominis muscle.
7. The rectus and pyramidalis muscles and the sheath of the rectus.
8. The transversalis fascia.
9. The inferior epigastric and deep circumflex iliac arteries.
10. The superior epigastric and musculo-phrenic arteries.

11. The spermatic cord.
12. The inguinal canal.
13. The extra-peritoneal fat.
14. The parietal peritoneum.
15. The obliterated umbilical artery.
16. The urachus.

Dissection.—**Reflection of Skin.**—*Incisions*—(1) Along the middle line of the body from the xiphoid process of the sternum to the symphysis pubis. The knife should be carried round the navel so as to surround it with a circular incision. (2) From the xiphoid process transversely round the thorax, as far back as the knife can be carried. (3) From the symphysis pubis laterally, along the line of the inguinal ligament, to the anterior superior spine of the ilium, and then backwards along the crest of the ilium (Fig. 91).

The large flap of skin thus mapped out must be carefully raised from the subjacent superficial fascia and turned laterally. If the abdominal wall is flaccid, the dissection may be facilitated by inflating the abdomen. Make an incision through the umbilicus, large enough to admit the nozzle of the bellows or an injection-pipe fixed to a bicycle-pump, and, when the walls are quite tense, secure the opening with twine, which should previously be sewn through the skin round the lips of the incision.

Panniculus Adiposus (Superficial Fascia).—The superficial fascia, laid bare by the reflection of the skin, presents the same appearance, and possesses the same general characters, as in other localities. Above, it is thin and weak, and is directly continuous with the corresponding fascia over the thorax; below, it becomes more strongly marked, and acquires a greater density. Towards the lower part of the abdomen the superficial fascia develops special characters; it consists of two layers—a fatty superficial stratum called *Camper's fascia*, and a deep membranous stratum termed *Scarpa's fascia.*

There is another point, however, in which the superficial fascia differs somewhat from the same fascia in other parts of the body. It is more elastic, the increased elasticity being due to the augmentation of the elastic fibres in its deeper membranous part. Over the lower part of the linea alba the elastic tissue is collected in the form of a distinct band, which descends, in front of the symphysis pubis, and becomes connected with the suspensory ligament of the penis. A reference to comparative anatomy gives interest to this fact. The elastic band in the human subject is the rudimentary representative of a continuous and distinct layer of yellow elastic tissue (*the abdominal tunic*), which is present in the horse and other quadrupeds in which the weight of the viscera is sustained chiefly by the abdominal wall.

As the two layers of the superficial fascia descend from

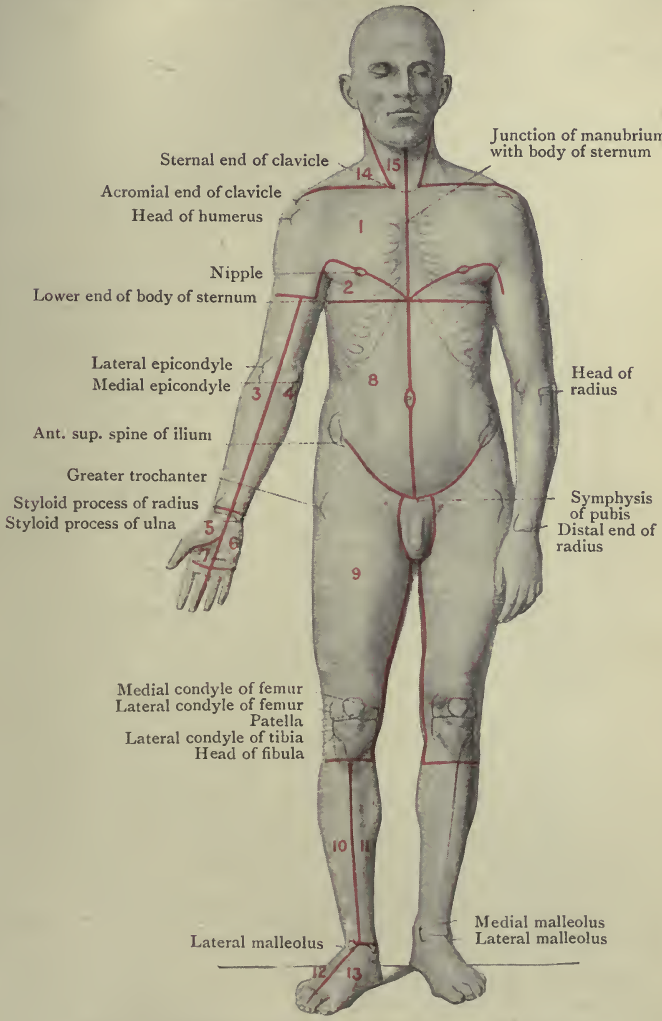


FIG. 91.—Surface view, with Incisions and Bony Points.

the front of the abdomen, the fatty layer of Camper passes over the inguinal ligament and becomes directly continuous with the fatty superficial fascia on the front of the thigh. The relations of the fascia of Scarpa are very different. In the region of the pubes it is carried continuously downwards over the spermatic cords, the penis and scrotum, into the perineum, where it becomes continuous with the fascia of Colles (see p. 152), which is attached, on each side, to the corresponding body of the pubis. On the lateral side of the spermatic cord, in the region of the groin, Scarpa's fascia ends, immediately distal to the inguinal ligament, by blending with the fascia lata of the thigh.

Dissection.—The connections of the fascia of Scarpa are so important that it is necessary to undertake a special dissection, in order that they may be demonstrated. As this dissection encroaches somewhat upon the region of the thigh, it must be done in conjunction with the dissector of the lower extremity. A transverse incision should be made through the entire thickness of the superficial fascia on the front of the abdomen from the anterior superior spine of the ilium to the median line of the abdomen. When the inferior edge of the divided fascia is raised the two layers can be easily distinguished. Insinuate the fingers between the fascia of Scarpa and the subjacent pearly-looking tendon of the external oblique muscle. Little resistance will be met, as the fascia of Scarpa is bound down to the deeper structures only by some lax areolar tissue. As the superficial fascia is raised from the aponeurosis of the external oblique, the anterior cutaneous branch of the ilio-hypogastric nerve will be seen piercing the aponeurosis and entering the deep surface of the superficial fascia, a little way above the subcutaneous inguinal ring. The fingers can be readily passed downwards behind the fascia of Scarpa as far as the inguinal ligament. There it will be found that they can force their way no farther. The passage of the hand into the thigh is barred by the blending of the fascia of Scarpa with the fascia lata of the thigh. At that level the fascia of Scarpa ceases to exist; it loses its identity by becoming fused with the deep fascia of the thigh along the line of, and immediately distal to, the inguinal ligament. Towards the pubes the finger can be pushed downwards behind the fascia of Scarpa and along the spermatic cord into the perineum. No barrier opposes the passage of the finger in that direction. The continuity of the fascia of Scarpa and the fascia of Colles is thus demonstrated.

If the dissector now recalls the fact that, in the urethral triangle of the perineum, the fascia of Colles is attached laterally to the margins of the pubic arch and to the anterior surfaces of the bodies of the pubic bones, and posteriorly to the base of the urogenital diaphragm, whilst above the level of the pubic crests it is continuous with the fascia of Scarpa on the front of the abdominal wall, he will have little difficulty in understanding the course which urine takes when extravasated from a rupture of the urethra below the urogenital diaphragm. The effused fluid is directed upwards into the scrotum over the penis, and along the spermatic cords to the

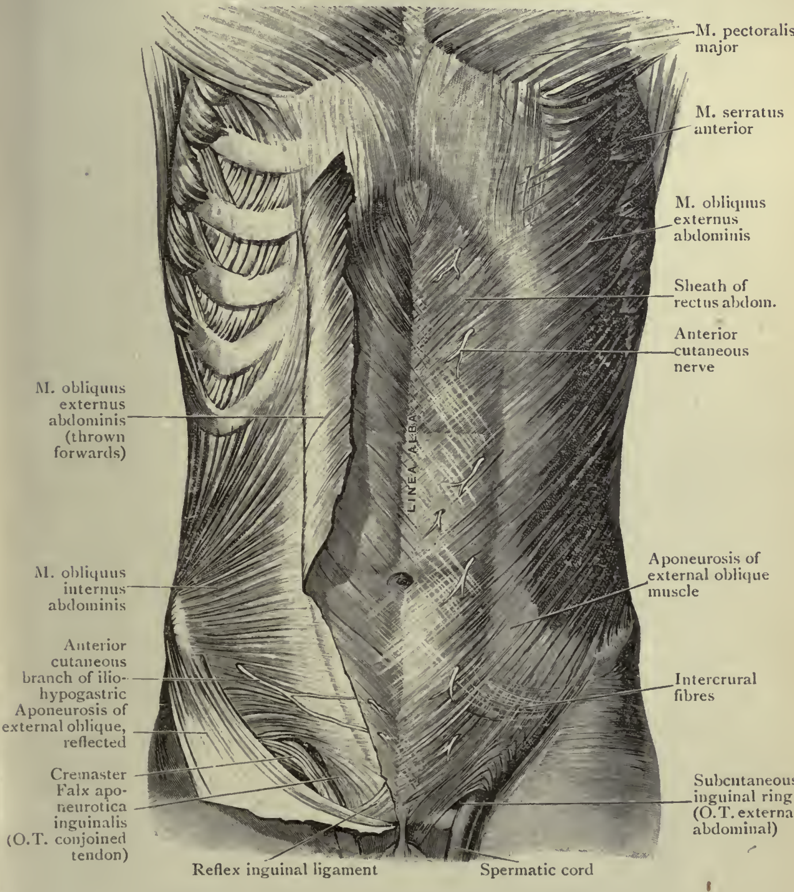


FIG. 92.—Dissection of Anterior Wall of the Abdomen.
The obliquus externus abdominis has been reflected on the right side.

front of the abdomen. From the abdomen it cannot pass downwards to the front of the thighs, owing to the attachment of Scarpa's fascia to the fascia lata. Unless vent be given to it by early and free incisions, it will continue to ascend over the abdomen between the superficial and the deep fascia.

Nervi Cutanei.—The cutaneous nerves of the anterior and lateral walls of the abdomen are arranged, in an *anterior* and a *lateral series*, on the same plan as the cutaneous nerves of the thorax (p. 5).

Anterior series.	1. Anterior cutaneous nerves. 2. Anterior cutaneous branch of the ilio-hypogastric nerve. 3. The ilio-inguinal nerve.
Lateral series.	1. Lateral cutaneous nerves. 2. Lateral cutaneous branch of the last thoracic nerve. 3. Lateral cutaneous branch of ilio-hypogastric nerve.

The *anterior cutaneous nerves* are the small terminal twigs of the lower five or six thoracic nerves. They pierce the aponeurotic sheath of the rectus muscle at variable points, some close to the median line and others a little distance from it. After entering the superficial fascia they run for a short distance laterally.

Dissection.—To display the anterior cutaneous nerves divide the superficial fascia along the middle line, and reflect it cautiously towards each side. Small arteries accompany the nerves, and serve as guides to their positions.

The *anterior cutaneous branch* of the ilio-hypogastric lies in series with the other anterior cutaneous nerves. When the superficial fascia was dissected it was seen piercing the aponeurosis of the external oblique a short distance above the subcutaneous inguinal ring.

The *ilio-inguinal nerve* passes out through the subcutaneous inguinal ring, and is distributed to the integument of the scrotum, or the labium majus, and the medial aspect of the thigh.

Dissection.—To display the lateral cutaneous nerves cut through the superficial fascia, along the posterior axillary line, from the upper part of the abdominal wall to the iliac crest; then reflect the anterior part of the divided fascia forwards and medially and secure the nerves as they emerge from between the digitations of the external oblique muscle. Each nerve divides into an anterior and a posterior branch. The anterior branches give twigs to the external oblique, and may be followed to the linea semilunaris. The posterior branches should be followed backwards over the lateral border of the latissimus dorsi.

The *lateral cutaneous nerves* are branches of the lower six thoracic nerves. They become superficial between the digitations of the external oblique muscle, and then each divides into an anterior and posterior division. The *posterior divisions* are small, and are directed backwards over the latissimus dorsi. The *anterior divisions* supply the external oblique muscle and then run forwards, and a careful dissector may trace them as far as the lateral margin of the rectus abdominis.

The *lateral cutaneous branch of the last thoracic nerve* differs from the other members of the series. It does not divide into an anterior and a posterior division, but descends to supply the integument over the gluteal region. It pierces the external oblique muscle, in a line with the other lateral nerves, and is then directed downwards over the crest of the ilium. It crosses the iliac crest from 25 to 50 mm. (one to two inches) behind the anterior superior spine.

The *lateral branch of the ilio-hypogastric nerve* also is distributed to the skin of the gluteal region. It pierces the external oblique immediately above the iliac crest, which it crosses usually opposite the tubercle which projects from the external lip of the crest, about 60 to 65 mm. (about two and a half inches) behind the anterior superior spine of the ilium.

Arteriæ Cutaneæ.—Some of the cutaneous arteries accompany the cutaneous nerves. Those which are associated with the lateral cutaneous nerves are branches of the *aortic intercostal arteries*, whilst those in relation to the anterior cutaneous nerves are derived from the *superior* and *inferior epigastric arteries.*

In addition *three* small branches of the femoral artery ramify in the superficial fascia of the groin.

These are—

1. The superficial external pudendal.
2. The superficial epigastric.
3. The superficial circumflex iliac.

They take origin in the thigh, a short distance distal to the inguinal ligament, and, after piercing the cribriform fascia or the fascia lata, diverge from each other in the superficial fascia.

Arteria Pudenda Externa Superficialis.—The superficial external pudendal artery is directed medially, over the spermatic cord. It gives branches to the skin of the scrotum and inferior surface of the penis.

Arteria Circumflexa Ilium Superficialis.—The superficial circumflex iliac artery passes laterally and upwards, along the line of the inguinal ligament (Pouparti), and ends in the skin in the neighbourhood of the anterior superior spine of the ilium.

Arteria Epigastrica Superficialis.—The superficial epigastric artery takes a course upwards and medially, and, after crossing the inguinal ligament, it ramifies in the superficial fascia over the inferior part of the abdomen. Its branches extend as high as the level of the umbilicus.

The small *veins* which accompany these arteries open into the great saphenous vein.

Muscles of the Abdominal Wall.—The abdominal wall is formed anteriorly and laterally by *five pairs of muscles*, and by the aponeuroses which constitute their tendons. *Anteriorly* are the two recti muscles and the two pyramidales muscles. The recti are placed parallel to the middle line, and extend vertically from the pubic bones to the lower margin of the thorax. *On each side* three fleshy and aponeurotic strata are met with. From the surface towards the abdominal cavity they are (1)—the external oblique muscle; (2) the internal oblique muscle; (3) the transversus abdominis muscle. The direction taken by the muscular fibres which compose each of the layers is different. The external oblique corresponds in direction with the external intercostal muscles; the fibres proceed obliquely downwards, forwards, and medially. The internal oblique resembles the internal intercostal muscles in the direction of its fibres; they are directed upwards, medially, and forwards; thus the fibres of the two oblique muscles cross each other like the limbs of the letter X. Lastly, the fibres composing the transversus abdominis muscle pursue a horizontal course.

The difference of direction of the fibres which compose the three strata is a source of strength to the part of the abdominal wall which they form, and the arrangement offers a strong barrier to the protrusion of any of the abdominal contents. The two oblique muscles and the transversus are prolonged to the middle line in the form of aponeuroses. The union of the aponeuroses of the opposite sides forms the *linea alba*—a strong band which extends, in the median line, from the symphysis pubis to the xiphoid process.

Dissection.—Remove the superficial fascia from the front of the abdomen and clean the aponeurosis of the external oblique muscle. Near the thorax the aponeurosis of the external oblique is very thin, and it is liable to injury, unless the dissection is performed with care. Proceed cautiously also at the lower part of the abdomen, above the medial end of the inguinal ligament. There the aponeurosis is pierced by the spermatic cord in the male, and by the round ligament of the uterus in the female. The lips of the opening thus formed are prolonged downwards upon the cord, or the ligament, in the form of a thin membrane called the *external spermatic fascia*. In defining this, the blade of the knife must not be used. Work entirely with the handle.

Next clean the muscular part of the external oblique. It may be cleaned either in the ordinary way by cutting through the thin deep fascia which covers the muscle along the line of the fibres, and then separating the fascia from the muscle by sweeping the knife forwards and backwards, along the surface of the muscle, parallel with the fibres, or, and in many cases more conveniently, by incising the fascia along a line at right angles to the fibres, over the posterior part of the muscle, and afterwards sweeping the knife across the surface of the muscle at right angles to the fibres as the fascia is reflected. At the anterior part of the muscle the deep fascia blends with the aponeurosis of insertion, which must not be injured. Finish the cleaning of the muscle by carefully defining the digitations of origin from the lower eight ribs.

FIG. 93. — Crest of the Ilium as seen from above (semi-diagrammatic), with Attachments of Muscles mapped out.

M. Obliquus Externus Abdominis.—The external oblique muscle arises, by *eight* pointed processes or digitations, from the outer surfaces and lower borders of the lower eight ribs (Vol. I. p. 45). The *upper three* digitations interdigitate with the digitations of the serratus anterior, and the latissimus dorsi interdigitates with the *lower four*. From their origins the fibres proceed downwards and forwards, with varying degrees of obliquity. The *posterior fibres* have a nearly vertical direction, and are inserted into the anterior half of the external lip of the crest of the ilium. The *superior fibres* are almost horizontal, and the *middle fibres* are directed obliquely downwards and forwards. All the superior and middle fibres end in a strong aponeurosis called the *aponeurosis of the external oblique*.

Superiorly, where the aponeurosis of the external oblique is very thin, it passes medially to be attached to the xiphoid process. It is from that part of the aponeurosis that the pectoralis major derives fibres of origin. *Inferiorly* the aponeurosis is folded upon itself to form the inguinal ligament, which is attached laterally and superiorly to the anterior superior spine of the ilium, and medially and inferiorly to the tubercle of the pubis. *Between the upper and lower attachments* the aponeurosis lies in front of the rectus, taking part in the

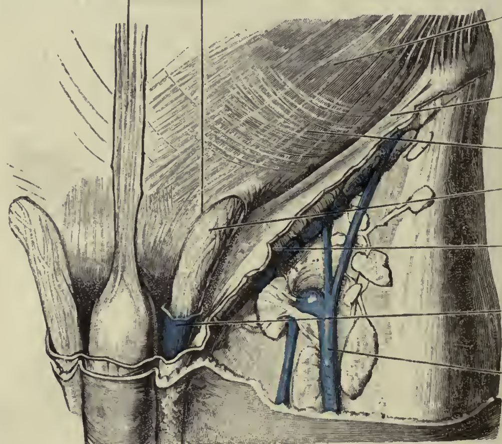


FIG. 94.—Dissection of the Subcutaneous Inguinal Ring and the parts in its vicinity.

formation of its sheath, and it is inserted into the linea alba and into the front of the os pubis.

The aponeurosis is broadest and strongest inferiorly ; it is narrowest about the level of the umbilicus, and it widens somewhat again towards the ribs. Superiorly it is so thin that the fibres of the rectus muscle shine through it.

Annulus Inguinalis Subcutaneus (O.T. **External Abdominal Ring**) (Figs. 94 and 95).—In the male, the aponeurosis of the external oblique is pierced, immediately above the pubis, by the spermatic cord ; in the female, it is pierced, at the same point and in the same manner, by the round ligament of the uterus. The aperture which is thus formed receives the name of the *subcutaneous inguinal ring*. At the present stage of the dissection the opening is not visible, because a thin fascial covering, the *external spermatic fascia*, is carried downwards from its lips upon the spermatic cord, or upon the round ligament of the uterus. When the cord is raised and rendered

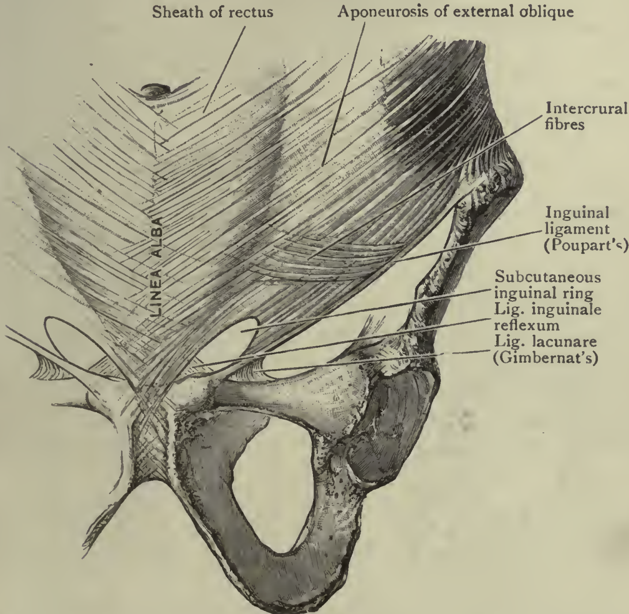


FIG. 95.—Dissection to show the connections of the inferior part of the Aponeurosis of the External Oblique Muscle.

tense, it is obvious that the covering invests it completely, and is somewhat funnel-shaped—wide above, but closing upon the cord as it is traced downwards.

> ***Dissection.***—With the point of the knife divide the external spermatic fascia around the cord, and then, with the handle, define the margins of the subcutaneous inguinal ring.

When the definition is completed the dissector will note that the term "ring," as applied to the opening, is apt to convey to the mind an erroneous impression. It is not circular, but triangular, in shape. The long axis of the opening is very oblique, the base of the triangle being formed by the crest of the pubis, whilst the apex is directed laterally and slightly upwards.

The subcutaneous inguinal ring, therefore, is merely a small gap or interval left between that portion of the aponeurosis of the external oblique muscle which forms the inguinal ligament, and that portion which is inserted into the front of the pubic bone. The margins of the aperture are termed *the crura of the ring.* The *superior crus* is flat and broad, and is attached to the body of the pubis. Some of its fibres cross the median plane, decussate with the corresponding fibres of the other side, and are inserted into the front of the opposite pubic bone. The *inferior crus* is merely the medial end of the inguinal ligament. It is, therefore, thick and strong, and is fixed to the pubic tubercle. The spermatic cord, as it issues from the subcutaneous inguinal ring, rests upon the inferior crus.

The *size* of the subcutaneous inguinal ring is very variable. In the male, the average length may be said to be 25 mm. (one inch), and the breadth about 12.5 mm. (half an inch). In the female, it is much smaller; and the round ligament of the uterus, which passes through it, ends in the superficial fascia of the groin.

On a close inspection of the lower part of the external oblique aponeurosis, the student will see a number of cross fibres arching over its surface. They are called the *intercrural fibres*, and in some cases they are very strongly marked. They begin at the inguinal ligament, close to the iliac spine, and curve upwards and medially, upon the aponeurosis, above the subcutaneous inguinal ring. The function of the intercrural fibres is very evident, and the term "*intercrural*" is derived from the part which they play. They bind together the two crura of the ring, and prevent their further separation. There is a direct continuity between the intercrural fibres and the external spermatic fascia which clothes the spermatic cord.

***Dissection.*—Reflection of the Obliquus Externus.—Between the last rib and the crest of the ilium the posterior border of the external oblique muscle is free, and as this border will be examined when the body is placed on its face it must not be disturbed at present. Begin by detaching the upper six serrations of the muscle from the ribs; from the interval between the sixth and**

seventh serrations carry an incision downwards, through the fibres of the muscle, to the posterior border of the tubercle on the external lip of the iliac crest. Raise the anterior portion of the muscle from the surface of the subjacent internal oblique and turn it medially, dividing the fleshy fibres inserted into the iliac crest close to the bone. Next, divide the aponeurosis horizontally, in a line leading from the anterior superior spine to the lateral border of the rectus. The greater part of the muscular and aponeurotic portion of the external oblique can now be thrown medially. The dissector must proceed with care on approaching the lateral border of the rectus, because a little beyond that border the anterior lamella of the aponeurosis of the internal oblique fuses with the deep surface of the aponeurosis of the external oblique. Define the line of union, and notice that it does not extend beyond the lower margin of the thorax. Above that the rectus is covered merely by the aponeurosis of the external oblique ; its lateral margin in that locality is bare, and the hand can be freely passed between the rectus muscle and the costal cartilages.

On the *left side* of the body, the parts below the horizontal line drawn from the anterior superior iliac spine to the lateral border of the rectus, along which the aponeurosis of the external oblique muscle has been divided, should be preserved intact for the special study of the structures associated with inguinal hernia. On the *right side* of the body, divide the lower part of the aponeurosis along the lateral border of the rectus down to the pubis. The incision should pass to the medial side of the superior crus of the subcutaneous inguinal ring, so that that opening may be preserved. The triangular flap of aponeurosis must now be thrown downwards and laterally. By this proceeding the inguinal ligament, the internal oblique muscle and the cremaster muscle are displayed for study.

Ligamentum Inguinale (Pouparti).—The inguinal ligament is merely the thickened lower border of the aponeurosis of the external oblique folded backwards upon itself. It thus presents a rounded surface towards the thigh and a grooved surface towards the abdomen. The manner in which it is attached by its lateral and medial extremities deserves the close study of the dissector. *Laterally* it is fixed to the anterior superior spine of the ilium ; *medially* it has a double attachment, viz.—(1) to the pubic tubercle, which may be considered as its attachment proper ; (2) through the medium of the lacunar ligament (*Gimbernat's*) to the ilio-pectineal line.

The inguinal ligament does not pursue a straight course between its iliac and pubic attachments. It describes a curve, the convexity of which is directed downwards and laterally towards the thigh. By its inferior border it gives attachment to the fascia lata. When that is divided, the inguinal ligament at once loses its curved direction.

Ligamentum Lacunare (Gimbernati) (Fig. 95).—The lacunar ligament is a triangular process of aponeurotic membrane. Raise the spermatic cord, or the round ligament of the uterus, place the finger behind the medial end of the inguinal ligament, and press downwards. The structure upon which the finger rests is the lacunar ligament, and the student should note that it offers a barrier to the passage of the finger into the thigh. With the handle of the knife, its shape and connections can be easily defined. Its *apex* is fixed to the pubic tubercle; by *one margin* it is attached to the medial part of the inguinal ligament; by its *other margin* it is inserted for the distance of an inch into the ilio-pectineal line. Its *base* is sharp, crescentic, and free, and is directed laterally towards the femoral sheath. The dissector should thoroughly realise that the lacunar ligament is not an independent structure. It is merely the medial part of the folded-back margin of the inguinal ligament which, in the vicinity of the pubic tubercle, obtains an attachment to bone.

The lacunar ligament occupies an oblique plane, its lower or femoral surface looking distally and slightly forwards and laterally, whilst its upper or abdominal surface looks upwards and slightly backwards and medially. It is of importance that the student should note the precise relation which this ligament bears to the spermatic cord. Taken in conjunction with the inguinal ligament and the aponeurosis of the external oblique, it forms a groove in which the cord lies.

Ligamentum Inguinale Reflexum (O.T. **Triangular Fascia**) (Fig. 95).—The reflex inguinal ligament is a small triangular sheet of fibres which springs from the crest of the pubic bone and the medial end of the ilio-pectineal line. It runs upwards and medially, under cover of the superior crus of the subcutaneous inguinal ring, and joins the linea alba. If the fibres which compose it are followed through the linea alba, they will be found to be continuous with the fibres of the aponeurosis of the external oblique muscle of the opposite side. It must, therefore, be considered as an additional insertion of that muscle. It is, frequently, so poorly developed that its true relations and connections are demonstrated with difficulty, if indeed they are capable of demonstration at all (Figs. 96, 98).

Dissection.—**The internal oblique muscle must now be cleaned. Towards its lower part it is pierced by certain nerves, and they**

must be preserved. Close to the iliac crest the *lateral branches* of the ilio-hypogastric and last thoracic nerves emerge from the midst of its fleshy fibres, whilst anteriorly it is pierced by the *anterior branch* of the ilio-hypogastric and by the *ilio-inguinal nerve*. The anterior branch of the ilio-hypogastric nerve appears near the anterior superior iliac spine, and then proceeds medially under cover of the external oblique aponeurosis, which it pierces near the lateral border of the sheath of the rectus abdominis. The ilio-inguinal nerve perforates the internal oblique a short distance medial to the hypogastric nerve and at a lower level. It becomes superficial by passing through the subcutaneous inguinal ring.

Care must be taken when defining the inferior margin of the muscle to preserve its relations to the spermatic cord, and not to injure the muscular fasciculi which it gives to the cremaster muscle.

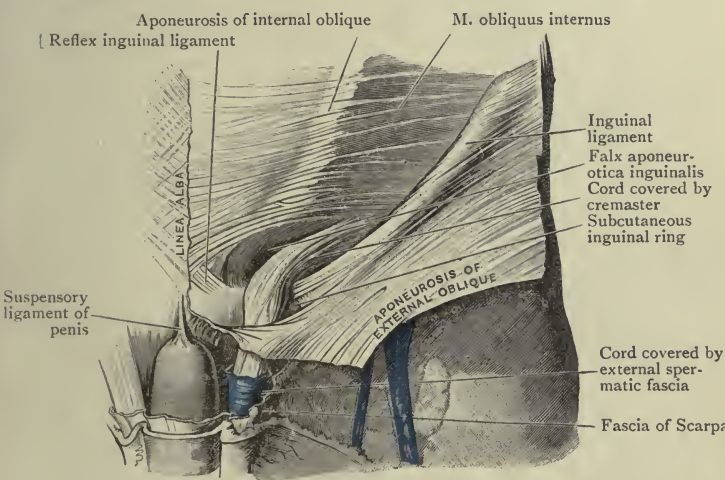


FIG. 96.—Dissection of the Inguinal Region.
The aponeurosis of the external oblique is turned down.

M. Obliquus Internus Abdominis (Fig. 92).—The internal oblique muscle *arises*—(1) from the lateral half of the abdominal grooved surface of the inguinal ligament; (2) from the intermediate line of the anterior two-thirds of the iliac crest; (3) from the lumbar fascia. The muscular fibres radiate from their origins, but their general direction is from below upwards and medially. The *posterior fibres* ascend, and are inserted into the lower borders of the cartilages of the lower four ribs. Those fibres occupy the same plane as the internal intercostal muscles—indeed, they will be observed to be directly continuous with the fibres of the internal intercostal muscles of the lower two spaces. The *lowest fibres*, those springing from the inguinal ligament, arch downwards and medially, and join with the lowest fibres of the transversus in a flat tendon, called the *falx inguinalis* (O.T. *conjoined tendon*), which is inserted into the pubic crest, and into the ilio-pectineal line, for fully 12.5 mm. (half an inch) of its extent, behind the lacunar ligament and the reflex inguinal ligament (Figs. 101 and 97). The *middle fibres* pass upwards and medially, and end in a strong aponeurosis, which extends from the inferior margin of the thorax to the pubis. By that aponeurosis they gain insertion into the inferior borders of the cartilages of the seventh and eighth ribs and the xiphoid process, and into the linea alba throughout its entire length. The manner in which the aponeurosis reaches the middle line requires special description.

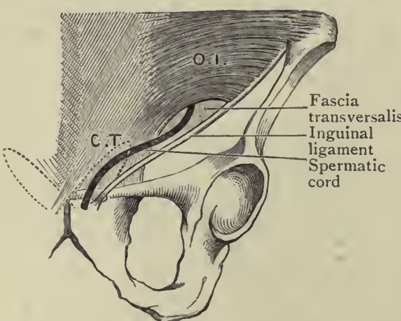


FIG. 97.—Diagram to illustrate the relation of the lower border of the Internal Oblique Muscle to the Cord, the Falx Inguinalis, and the Inguinal Canal.

O.I. Internal oblique muscle.
C.T. Falx Inguinalis.

The position of the subcutaneous inguinal ring is indicated by a dotted outline.

At the lateral margin of the rectus muscle the aponeurosis of the internal oblique splits into two layers—a superficial and a deep. The *superficial layer of the aponeurosis* passes in front of the rectus, and has already been seen to fuse with the aponeurosis of the external oblique muscle. The *deep layer* is carried medially behind the rectus, and becomes incorporated with the subjacent aponeurosis of the transversus muscle. But this arrangement does not hold good lower down than a point about midway between the umbilicus and the pubis. Below that point the aponeurosis does not split, but passes entirely in front of the rectus to join the aponeurosis of the external oblique.

It is important to mark exactly the relation which the inferior part of the muscle bears to the spermatic cord. At first the cord lies behind the fleshy fibres, but it soon emerges, clothed by the cremaster muscle, and, as it is continued downwards and medially to the subcutaneous inguinal ring, it lies in front of the falx aponeurotica inguinalis (O.T. conjoined tendon). Especially note the position of the falx inguinalis in relation to the subcutaneous inguinal ring. It lies immediately behind it, and gives strength to that otherwise weak point in the abdominal parietes.

M. Cremaster.—The cremaster muscle supports the testis and spermatic cord, and is consequently peculiar to the male. It *arises* from the medial part of the inguinal ligament, and it derives fibres also from the inferior border of the internal oblique (rarely from the inferior border of the transversus abdominis muscle). The fleshy fibres descend upon the lateral and anterior aspects of the cord in the form of loops, the concavities of which are directed upwards. The depth to which the loops descend varies. Some reach the tunica vaginalis of the testis, and the scrotum should now be opened up, on the right side, in order that they may be traced downwards to their terminations; the majority of the fibres, however, do not reach so far down, some going no farther than the subcutaneous inguinal ring. Upon the posterior aspect of the cord the loops are directed upwards, and some, reaching the os pubis, obtain a tendinous insertion into its tubercle and crest.

It will be noticed that the cremasteric fleshy loops do not form a complete investment for the cord and testis. The intervals between the fasciculi are occupied by areolar tissue, and the combination of muscular and areolar tissue is sometimes termed the *cremasteric fascia*.

Dissection.—Reflection of Internal Oblique.—On the *right* side of the body the entire muscle may be reflected, but on the left side preserve the inferior portion of it (*i.e.*, that part which is still covered by the aponeurosis of the external oblique) *in situ*. Begin below by dividing the muscular fibres along the crest of the ilium. The depth to which the knife should be carried is indicated by the dense areolar tissue which lies between the internal oblique and the subjacent transversus muscle. An ascending branch from the deep circumflex iliac artery will also serve as a guide. That vessel emerges from the fibres of the transversus muscle and then runs upwards upon its surface, close to the anterior part of the iliac crest. Although the vessel has not attained the dignity of a name, it is a very constant branch. On the right side the fibres springing from the inguinal ligament should also be severed, but on the left side carry the knife horizontally, from the anterior superior spine of the ilium to the lateral margin of the rectus. Now turn to the upper part of the muscle, and make an incision through it, along the lower margin of the thorax, from the lateral border of the rectus to the last rib. Lastly, carry the knife downwards, from the tip of the last rib to the crest of the ilium.

The muscle freed in this manner can be reflected medially towards the lateral border of the rectus, but the dissector must proceed with caution, because he has reached the plane of the main trunks of the nerves of the abdominal wall and the arteries which accompany them. The nerves and vessels pass medially between the internal oblique and the transverse muscles, and, as the former muscle is raised, they are apt to adhere to its deep surface and will be cut if proper care is not exercised.

In all probability the student will experience considerable difficulty in separating the lowest part of the internal oblique from the corresponding portion of the transversus abdominis, for the lower parts of the two muscles are always closely connected, and in some cases they are partially blended.

On the right side the *cremaster muscle* should also be reflected from the spermatic cord. That can best be done by making a longitudinal incision through its fibres. Entering the deep surface of the cremaster are a small *branch of the inferior epigastric artery* and the *external spermatic nerve* (*a branch of the genito-femoral*). They constitute its vascular and nervous supply, and must, if possible, be secured. Now clean the transversus abdominis muscle, and the vessels and nerves which lie upon it.

Nerves of the Abdominal Wall.—The dissector will find the following nerves running forwards upon the transversus abdominis muscle :—

1. The anterior branches of the lower six thoracic nerves.
2. The ilio-hypogastric nerve. } From the anterior ramus of the first
3. The ilio-inguinal nerve. } lumbar nerve.

The *anterior branches of the lower six thoracic nerves* enter the abdominal wall at the margin of the costal arch, where they insinuate themselves between the internal oblique and the transversus abdominis muscles. Then they run to the lateral border of the rectus muscle, where they disappear by piercing the posterior lamella of the internal oblique aponeurosis, and passing within the sheath of the rectus. In a subsequent dissection they will be seen sinking into the substance of the rectus, supplying it with twigs, and then turning forwards to pierce the front of the sheath. They end on the front of the abdomen as the *anterior cutaneous nerves.* They supply offsets to the internal oblique and also to the transversus abdominis. Minute arteries accompany the nerves.

The *anterior branch of the last thoracic nerve* also supplies the oblique and transverse muscles, and, in addition, it gives a branch to the pyramidalis muscle.

The lateral branches of the lower thoracic nerves have already been exposed and studied (p. 204).

The *ilio-hypogastric* and *ilio-inguinal* are the lowest two nerves of the series. They are directed forwards between the internal oblique and the transversus, close to the crest of the ilium.

The ilio-hypogastric is the higher of the two. It gives off an *iliac* or *lateral cutaneous branch*, which pierces the two oblique muscles, and then crosses the crest of the ilium to reach the skin of the gluteal region. The *anterior portion* of the nerve perforates the internal oblique, a short distance in front of the anterior superior spine of the ilium, and then runs forwards towards the linea alba. It does not enter the sheath of the rectus, but becomes superficial by piercing the aponeurosis of the external oblique above the subcutaneous inguinal ring.

The *ilio-inguinal nerve* gives off no lateral branch. It pierces the internal oblique, to which it gives branches, a short distance above the inguinal ligament, and it becomes superficial by passing through the subcutaneous inguinal ring.

M. Transversus Abdominis.—The transversus abdominis muscle is the deepest of the three muscular strata which enter into the formation of the wall of the abdomen. It has a threefold origin, viz.—from the pelvis, from the vertebral column, and from the costal cartilages. By its *pelvic origin* it is attached to the lateral third of the inguinal ligament and to the anterior two-thirds of the internal lip of the crest of the ilium; by its *costal origin* it arises from the inner surfaces of the costal cartilages of the lower six ribs, by a series of slips or digitations which interdigitate with the slips of origin of the daphragm; by its *vertebral origin* it is attached, through the medium of the lumbo-dorsal fascia, to the spinous processes, and the tips and roots of the transverse processes, of the lumbar vertebræ (Fig. 98). Indeed, the lumbo-dorsal fascia constitutes the posterior aponeurosis of the muscle. The manner in which the lumbo-dorsal fascia is attached to the vertebræ needs further explanation. As it approaches the vertebral column it splits into three layers or lamellæ; the *posterior lamella* is attached to the tips of the spinous processes, the *anterior lamella* to the roots of the transverse processes, and the *middle lamella* to the tips and adjacent sides of the transverse processes. Two compartments are thus formed; the posterior of the two is occupied by the sacro-spinalis (O.T. erector spinæ), whilst the anterior contains the quadratus lumborum. The points referred to cannot be demonstrated at this stage of the dissection, but a reference to Fig. 98 will help the student to understand the arrangement.

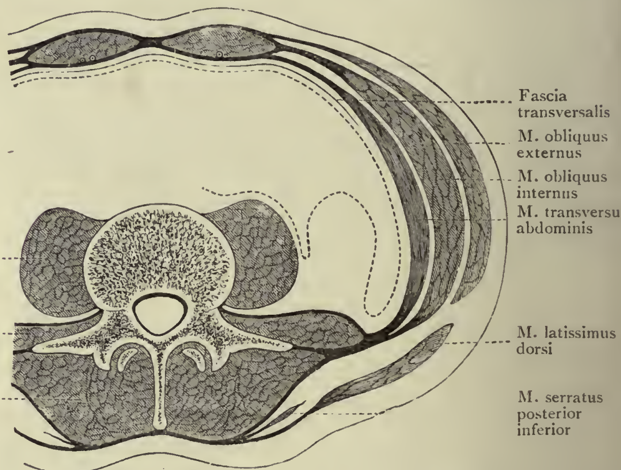


FIG. 98.—Lumbo-dorsal fascia and sheath of Rectus abdominis. The dotted line represents the Peritoneum.

Anteriorly, the fibres of the transversus abdominis muscle end in a strong aponeurosis, which is inserted into the linea alba, the pubic crest, and the ilio-pectineal line. Towards the aponeurosis the fleshy fibres for the most part run in a transverse direction. The lower fibres, however, take a curved course downwards and medially, so that the muscle presents an arched lower margin.

The dissector has already seen that the lowest portions of the aponeuroses of the internal oblique and the transverse muscles blend to form the *falx inguinalis* (O.T. *conjoined tendon*). It is through the medium of the falx inguinalis that the transversus abdominis gains its insertion into the pubic crest and into the ilio-pectineal line. The aponeurosis of the

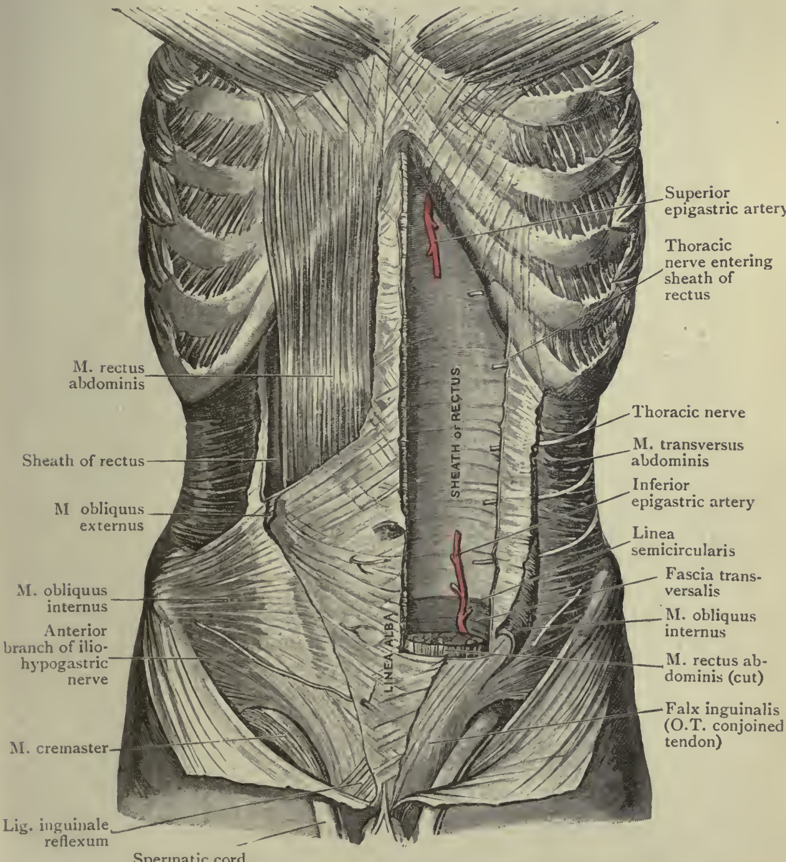


FIG. 99.—Deep dissection of the Anterior Wall of the Abdomen. On the *left side* the external oblique and the internal oblique have for the most part been removed, the sheath of the rectus opened, and the greater part of the contained muscle removed. On the *right side* the external oblique, the upper part of the internal oblique, and the upper part of the anterior wall of the sheath of the rectus have been removed.

transversus abdominis constitutes the greater portion of the falx inguinalis—indeed, whereas the internal oblique aponeurosis has an attachment to the ilio-pectineal line of little more than 12.5 mm. (half an inch), the aponeurosis of the transversalis is fixed to fully one inch of that line.

Above the level of the falx inguinalis the aponeurosis of the transversus is inserted into the linea alba, but in passing medially to that insertion it presents two different relations to the rectus muscle. Down to a point midway between the umbilicus and pubes it passes *behind* the rectus, and blends with the posterior lamella of the aponeurosis of the internal oblique. Below that point it passes *in front of* the rectus, and blends with the aponeuroses of the internal oblique and external oblique.

The two oblique muscles and the transversus are very efficient protectors of the abdominal contents; they contract and become firm and hard when blows or pressure threaten or impinge upon the abdominal wall. They help the other muscles of the abdominal wall to maintain the intra-abdominal pressure by means of which the abdominal viscera are kept in position. They are muscles of expiration, because when they contract they press upon the abdominal viscera, tending to force them towards the thorax, so elevating the diaphragm and reducing the capacity of the thorax. They also play a part in defæcation, for their contraction increases the intra-abdominal pressure and so helps the rectum to evacuate its contents. All three muscles are supplied by the anterior branches of the lower six thoracic nerves, and by the anterior branch of the ilio-hypogastric nerve.

Dissection.—Turn now to the sheath of the rectus abdominis and note that crossing it transversely are three linear thickenings, the *lineæ transversæ.* One lies at the level of the xiphoid process of the sternum, another at the level of the umbilicus, and the third is midway between the other two. Occasionally a fourth transverse linear thickening is present below the umbilicus. Divide the sheath by a vertical incision along the middle line of the muscle, then raise the medial and lateral parts of the divided sheath from the surface of the muscle, reflect the medial part towards its attachment to the linea alba, and the lateral part towards the lateral border of the muscle. Between the lineæ transversæ the sheath can be separated from the muscle with the handle of the scalpel, but at the lineæ transversæ the front of the sheath is blended with tendinous intersections in the muscle, and the edge of the scalpel must be called into play. As the flaps of the sheath are raised the anterior cutaneous nerves must be preserved.

Contents of the Sheath of the Rectus.—Within the sheath of the rectus are the following structures:—

1. The rectus muscle.
2. The pyramidalis muscle.
3. The terminal portions of the anterior branches of the lower six thoracic nerves.
4. The inferior epigastric artery, some of its branches, and venæ comites.
5. The superior epigastric artery, some of its branches, and venæ comites.

Dissection.—The front part of the sheath of rectus abdominis has already been turned aside, now look for the pyramidalis; if it is present it will be found in the lower part of the sheath, in front of the rectus, extending from the front of the os pubis and the ligaments of the symphysis pubis to the lower part of the linea alba; clean it, then detach it from the linea alba, and turn it downwards. As it is reflected secure its nerve of supply. It is a twig of the last thoracic nerve which pierces the rectus and enters the deep surface of the pyramidalis. After the attachments of the pyramidalis have been displayed, raise the lateral border of the rectus with the handle of the scalpel, and secure the terminal parts of the anterior branches of the lower six thoracic nerves as they enter the sheath after piercing the posterior lamella of the aponeurosis of the internal oblique muscle. Note that the nerves are associated with small branches of the superior and inferior epigastric arteries which leave the sheath through the openings by which the nerves enter.

The posterior surface of the rectus muscle, unlike the anterior surface, is not attached to the sheath by lineæ transversæ; therefore it can easily be raised from the posterior part of the sheath and the nerves can be followed into the substance of the muscle. When the facts mentioned have been verified, cut the nerves between the points where they enter the sheath and the points where they enter the muscle, and at the same time cut the small arteries which lie beside the nerves; then divide the rectus abdominis about the middle of its length. Turn the upper part of the divided muscle upwards and secure the superior epigastric artery which descends into the sheath behind the costal cartilages and then enters the muscle, and define the attachments of the muscle to the xiphoid process of the sternum, and the cartilages of the seventh, sixth, and fifth ribs. Throw the lower part of the muscle downwards, secure the inferior epigastric artery as it enters the sheath about midway between the umbilicus and the pubis, then define the inferior attachments of the muscle to the crest of the os pubis and the front of the symphysis pubis.

M. Pyramidalis.—The pyramidalis is a small triangular muscle—not always present—which springs from the front of the pubis and the ligaments of the symphysis, and is inserted into the linea alba. It lies anterior to the lower part of the rectus. It is a tensor of the linea alba and is supplied by the last thoracic nerve.

M. Rectus Abdominis.—The rectus abdominis is a broad band of muscular fibres which stretches between the thorax and the pubes, at the side of the linea alba. Inferiorly, it *arises* by two heads; the lateral and larger of the two is attached to the pubic crest, whilst the medial and smaller is fixed to the ligaments in front of the symphysis pubis. Towards the thorax the muscle widens and becomes thinner, and its *insertion* is effected by three large slips into the anterior aspect of the costal cartilages of the *fifth*, *sixth*, and *seventh ribs*, and by a smaller slip to the xiphoid process of the sternum.

The rectus muscle is broken up into segments by irregular tendinous intersections—the *inscriptiones tendineæ* or *lineæ transversæ*. They are usually three in number, and are placed, one at the level of the umbilicus, another opposite the xiphoid process, and a third midway between. A fourth intersection is sometimes found below the level of the umbilicus. The tendinous intersections are adherent to the anterior part of the sheath of the rectus; but they have no attachment to the posterior part of the sheath.

The rectus abdominis protects the abdominal contents. It becomes firm and hard when pressure on the front of the abdominal wall threatens or occurs, and by its tonicity it helps to maintain the intra-abdominal pressure. It depresses the ribs to which it is attached and presses upon the abdominal contents. It is, therefore, a muscle of expiration and defæcation, and, as it pulls the front of the thorax downwards towards the symphysis, it is a flexor of the vertebral column. It is supplied by the anterior branches of the lower six thoracic nerves.

Vagina Recti Abdominis (Sheath of the Rectus).—The dissector is now in a position to study the manner in which the sheath of the rectus is formed. An examination of the relations which the aponeuroses of the three flat muscles of the abdomen bear to the rectus will show that the sheath is incomplete, and does not entirely surround the rectus. It is deficient *posteriorly*, both above and below.

From the lower margin of the thorax to a point midway between the umbilicus and pubes it encloses the rectus upon all sides. In that part of its extent the *anterior wall* is formed by the aponeurosis of the external oblique fused with the anterior layer of the aponeurosis of the internal oblique, whilst the *posterior wall* is formed by the posterior layer of the aponeurosis of the internal oblique fused with the aponeurosis of the transversus abdominis (Fig. 98).

Superiorly, the rectus muscle rests directly upon the costal cartilages, and the sheath is represented merely by the aponeurosis of the external oblique, which covers the muscle anteriorly. *Inferiorly* also, the posterior wall of the sheath is absent, and the rectus rests on the transversalis fascia. There the anterior wall is formed by a blending of all three aponeuroses (Fig. 100).

The lower free margin of the posterior wall of the sheath can be defined with the handle of the knife after the rectus is raised. It frequently presents a sharp lunated edge, the concavity of which is directed downwards towards the pubis. The curved edge is called the *linea semicircularis* (O.T. *semilunar fold of Douglas*). The inferior epigastric artery enters the sheath by passing upwards in front of the linea semicircularis (Fig. 99).

The linea semicircularis is, however, often rendered in-

FIG. 100.—Transverse section through the Abdominal Wall a short distance above the Pubes.

distinct by the presence of scattered tendinous bundles crossing behind the lower part of the rectus.

Linea Alba.—The linea alba can now be studied to the best advantage. It is a dense fibrous cord or band which extends perpendicularly between the xiphoid process and the symphysis pubis. It is formed by the union and decussation of the fibres composing the aponeuroses of the two oblique muscles and the transverse muscles of opposite sides. Above the umbilicus it is broad and band-like; whilst below that point it becomes narrow and linear. A close examination will show that it is pierced by several small round openings, for the transmission of blood-vessels, and from some of these the dissector may observe minute fatty masses protruding. A little below its middle is the umbilicus, but the foramen of which the umbilicus is the remains, is completely closed at birth; indeed, in the adult the linea alba is stronger at that point than elsewhere.

Fascia Transversalis.—The transversalis fascia is a thin layer of fascia which is spread out upon the deep surface of the transversus abdominis muscle. The fascia of one side is directly continuous, behind the sheaths of the recti abdominis, with the fascia of the opposite side, and forms a part of an extensive fascial stratum which lines the entire abdominal wall, and is placed between the abdominal muscles and their

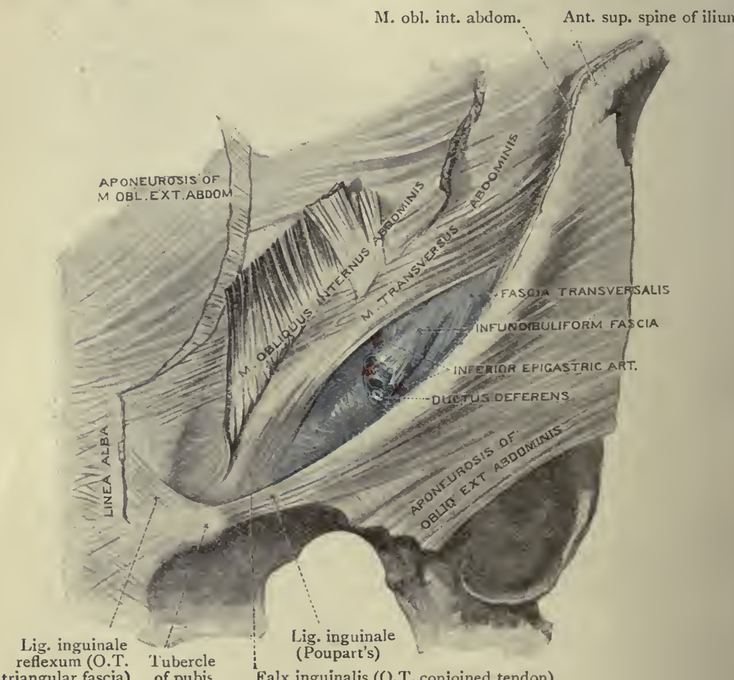


FIG. 101.—Deep dissection of the Inguinal Region. The internal oblique has been reflected to show the whole length of the inguinal canal; and the cord, enclosed within the internal spermatic fascia, is seen cut across.

aponeuroses on the one hand, and the extra-peritoneal fatty tissue on the other.

Traced upwards, the fascia transversalis becomes thin and, at the margin of the thorax, it is directly continuous with the diaphragmatic fascia which covers the lower surface of the diaphragm. In the inguinal region it plays an important part as a constituent of the posterior wall of the inguinal canal.

In the present state of the dissection (on the right side of the body), a small gap or interval is seen to exist between the arched lower border of the transverse muscle and the inguinal ligament. The membrane which fills up that interval is part of the *transversalis fascia.* At no part of the abdominal wall is the transversalis fascia stronger than in that region, and the accession of strength is obviously for the purpose of compensating for the deficiency in the transverse muscle, which, in that area, does not descend so low as the inguinal ligament. In the area the transversalis fascia has an important relation to the spermatic cord. It is pierced by the cord, but as yet no opening is visible. Take hold of the cord and draw it downwards and medially. The margins of the aperture through which it passes will be observed to be prolonged downwards upon the cord in a funnel-shaped manner, so as to invest it upon all sides with a tube of fascia. The investment, which is thus seen to come directly from the fascia transversalis, is called the *internal spermatic fascia.*

***Dissection.*—It is now the object of the dissector to demonstrate the more important attachments of the transversalis fascia. He must, therefore, divide the fibres of the transverse muscle along the lateral part of the inguinal ligament and along the crest of the ilium, and, raising the muscle from the subjacent fascia, throw it upwards. It is not necessary to reflect the entire muscle.**

Attachments of the Fascia Transversalis.—When the fascia is cleaned with the handle of the scalpel, it will be seen to be attached *laterally* to the internal lip of the iliac crest. Along the line of that attachment, which is by no means firm, it becomes continuous with the *fascia iliaca*, which is merely the portion of the same fascial stratum covering the iliacus and psoas muscles in the iliac fossa. Close to the crest of the ilium the fascia transversalis is pierced first by the ascending branch, and then by the deep circumflex iliac artery itself. *Anteriorly*, in the inguinal region, its connections are more complicated, and must be studied at three different points — (1) between the anterior superior spine of the ilium and the femoral artery, where it will be seen to be attached to the inguinal ligament; along that line also it becomes continuous with the fascia iliaca; (2) opposite the femoral vessels, where it is carried distally into the thigh behind the inguinal ligament, to form the anterior part of the femoral sheath (Vol. I., p. 240); (3) medial to the femoral vessels, where it is attached to the pectineal line or pecten of the superior ramus of the pubis, behind the falx inguinalis (O.T. conjoined tendon), with which it is partially blended.

Annulus Inguinalis Abdominalis (Abdominal Inguinal Ring).—It has been noted that the transversalis fascia is pierced by the spermatic cord. The opening through which it passes is called the *abdominal inguinal ring* (O.T. internal abdominal ring). The margin of the ring is prolonged downwards on the cord as the internal spermatic fascia. It follows, therefore, that the opening can be defined, from the front, only by an artificial dissection, viz.—by dividing the internal spermatic fascia around the cord and pushing it upwards with the handle of the knife. The ring thus defined lies about 12.5 mm. (half an inch) above the inguinal ligament, at a point midway between the symphysis pubis and the anterior superior spine of the ilium. Through the opening the dissector will see the extra-peritoneal fat, upon which the transversalis fascia rests, and, just medial to the opening, the inferior epigastric artery is visible through the fascia, pursuing its oblique course upwards and medially. If the handle of the knife is now introduced into the ring and carried laterally between the fascia and extra-peritoneal fat, the attachments of the fascia to the inguinal ligament and to the iliac crest can be demonstrated.

Canalis Inguinalis (Inguinal Canal).—It has been shown that the spermatic cord, in the male, and the round ligament, in the female, pierce the abdominal wall above the inguinal ligament. The passage which is formed for their transmission receives the name of the *inguinal canal.* The canal is a source of weakness to the abdominal wall; and it is in connection with it that inguinal hernia occurs, and the student will understand, therefore, how necessary it is that he should examine its position and its walls carefully from all points of view.

The *inguinal canal* is a narrow channel of about 38 mm. (one inch and a half) in length. It begins at the abdominal inguinal ring, which may be spoken of as its inlet, and ends at the subcutaneous inguinal ring, which constitutes its outlet. It is, consequently, very oblique, having a direction almost directly medialwards, with a slight inclination downwards and forwards. So much for its length and direction;

its floor, its anterior wall, and its posterior wall have still to be examined.

The *floor* of the lateral and deeper part of the canal is formed by the upper grooved surface of the inguinal ligament. Towards the outlet, however, the floor becomes broader and more definite; there it is formed not only by the inguinal ligament, but also by the lacunar ligament. At that point, as the dissector has previously noted, the cord rests directly upon the abdominal surface of the lacunar ligament. The parts which enter into the formation of the *anterior wall* are—(1) the aponeurosis of the external oblique, throughout the entire extent of the canal; and (2) the lower border of the internal oblique, in the lateral third of the canal. These facts can be readily verified if the structures are restored to their original positions. The parts which compose the *posterior wall* are still *in situ*. Named in order, from the inlet to the outlet, they are—(1) the fascia transversalis; (2) the falx inguinalis; and (3) the ligamentum inguinale reflexum, when that structure is developed (Fig. 102).

But it may be asked, does the transversus abdominis muscle take no part in the formation of the inguinal canal? The student can readily satisfy himself as to that point. He will notice that the arched lower border of the transversus muscle does not descend so low as the lower border of the internal oblique; that, in fact, it stops short immediately above the abdominal inguinal ring. Therefore the transversus abdominis takes no part in the formation of the anterior wall of the canal. The canal is closed superiorly by the approximation of the anterior and posterior walls, above the cord, and by the intervention between the walls of the lower border of the transversus abdominis.

There is still another point to be noted, viz., the relation which the inferior epigastric artery bears to the posterior wall of the canal. That vessel can be felt (and, indeed, in most cases seen) extending obliquely upwards and medially, posterior to the transversalis fascia, to the lateral border of the rectus. A triangular area is thus mapped out by the artery, the inguinal ligament, and the lateral border of the rectus. It receives the name of the *triangle of Hesselbach*. The triangle lies behind the posterior wall of the inguinal canal, and chiefly behind that part of it which is formed by the falx inguinalis (O.T. conjoined tendon).

In the female the inguinal canal is much smaller than in the male. It has the same boundaries; and it is traversed by the round ligament of the uterus.

Arteries of the Abdominal Wall.—The following arteries will be found in the abdominal wall:—

1. Intercostal and lumbar arteries.
2. The inferior epigastric artery.
3. The deep circumflex iliac artery.
4. The superior epigastric artery.
5. The musculo-phrenic artery.

The *intercostal arteries* of the lower two spaces are prolonged forwards between the internal oblique and the transversus abdominis. They have already been noted accompanying the corresponding nerves. In front, they anastomose with branches of the epigastric arteries, whilst, inferiorly, they effect communications with the lumbar arteries.

The *main stems* of the *lumbar arteries* ramify between the same two muscles as the preceding vessels, but at a lower level in the abdominal wall. Anteriorly, they anastomose with branches of the inferior epigastric artery; above, with the intercostal arteries; and below, with the deep circumflex iliac and the ilio-lumbar arteries.

Arteria Epigastrica Inferior (O.T. Deep Epigastric Artery).—The inferior epigastric branch of the external iliac artery is a vessel of some size. It takes origin about a quarter of an inch above the inguinal ligament. At present it is seen shining through the fascia transversalis and forming the lateral boundary of Hesselbach's triangle. Divide the fascia transversalis along its course and note the two veins which accompany the artery; then study the course and relations of the vessel. At first it runs medially for a short distance, between the inguinal ligament and the abdominal inguinal ring, and then, changing its direction, it is carried upwards and medially on the medial side of the ring towards the lateral border of the rectus abdominis. Continuing upward behind the rectus abdominis it pierces the transversalis fascia, then, passing in front of the linea semicircularis, it enters the sheath of the rectus, in which it ascends vertically, and it terminates, at the level of the lower margin of thorax, in branches which enter the substance of the rectus, where they anastomose with the ramifications of the superior epigastric artery.

In the lower parts of its course the artery is embedded in the extra-peritoneal fat between the peritoneum and the fascia transversalis; then, having pierced that fascia, it is situated between the fascia and the posterior surface of the rectus; finally, having passed in front of the linea semicircularis, it lies between the rectus and the posterior wall of the sheath of that muscle. In addition to the relations mentioned it has others of equal importance, viz., (1) as it runs upwards it lies close to the medial side of the abdominal inguinal ring; (2) as the spermatic cord traverses the commencement of the inguinal canal it lies in front of the artery, separated from it only by transversalis fascia; (3) as the ductus deferens, or the round ligament of the uterus, passes from the inguinal canal into the abdominal cavity it hooks round the lateral side of the artery.

The *branches* which spring from the inferior epigastric are—

1. External spermatic.
2. Pubic.
3. Muscular.
4. Cutaneous.
5. Anastomotic.

The *external spermatic* is a small twig which supplies the cremaster muscle and anastomoses with the internal spermatic artery. The *pubic*, also insignificant in size, runs medially on the pubis, and sends downwards an obturator branch which anastomoses with a small branch from the obturator artery. The importance of the pubic branch arises from the fact that the anastomosis which it establishes sometimes becomes so large as to take the place of the obturator artery. The *muscular branches* are given to the substance of the rectus, and the *cutaneous offsets* pierce the abdominal muscles and anastomose with the superficial epigastric artery. The *anastomotic branches* pierce the posterior lamella of the internal oblique aponeurosis and anastomose, between the transversus abdominis and the internal oblique muscles, with the lower intercostal, the subcostal, and the lumbar arteries.

Arteria Circumflexa Ilium Profunda.—The deep circumflex iliac artery springs from the lateral side of the external iliac artery, about the same level as the inferior epigastric, and runs laterally, behind the inguinal ligament, to the anterior superior spine of the ilium. From that point onwards it takes the crest of the ilium as its guide, and it ends by anastomosing with branches of the ilio-lumbar artery. At first it is placed in the extra-peritoneal fat, between the fascia transversalis and the peritoneum. Its course behind the inguinal ligament is indicated by a whitish line, which marks the union of the fascia transversalis and fascia iliaca. If the transversalis fascia is divided along that line the deep circumflex iliac artery will be exposed. At the anterior superior spine of the ilium the vessel pierces the fascia transversalis, and lies between that and the transversus muscle; and lastly, about the middle point of the iliac crest, it pierces the transversus muscle, and its terminal twigs ramify between the transversus abdominis and the internal oblique muscles. Thus the artery gradually approaches the surface, as it passes from its origin to its termination.

The dissector has already seen the *ascending branch* which it sends upwards between the internal oblique and transverse muscles.

Art. Epigastrica Superior et Art. Musculo-phrenica.—The superior epigastric and the musculo-phrenic arteries are the two terminal branches of the internal mammary artery.

The *superior epigastric* will be found behind the rectus muscle and within the upper part of its sheath. It gives twigs to the rectus, and anastomoses with the inferior epigastric and the intercostal arteries.

Dissection.—To expose the musculo-phrenic artery detach the transversus abdominis from its attachments to the rib cartilages. The artery will be found, if the injection of the arteries has been good, at the level of the eighth or ninth costal cartilage, where it passes through the diaphragm. Follow it along the costal margin, across the abdominal surface of the costal origins of the diaphragm.

The Musculo-phrenic.—In the abdomen the musculo-phrenic artery passes downwards and laterally, along the costal origin of the diaphragm, from the point where it pierces the diaphragm to the last intercostal space. Before or after it enters the abdomen it supplies anterior intercostal branches to the seventh, eighth, and ninth intercostal spaces (see p. 121). After it enters the abdomen it gives branches to the diaphragm, and other branches which anastomose with twigs from the superior epigastric and the lower two aortic intercostal arteries.

Dissection.—The transversus has already been detached from the inguinal ligament and the crest of the ilium (p. 225), and also from the rib cartilages. Now divide it vertically between the ribs and the iliac crest, and throw it towards the median plane, carefully detaching the transversalis fascia from its deep surface. The muscle fibres end anteriorly in an aponeurosis; the lower part of the aponeurosis, which blends with the lower part of the aponeurosis of the internal oblique to form the falx inguinalis, has already been examined (see p. 214). The upper part enters into the formation of the sheath of the rectus abdominis ; from the lower margin of the thorax to halfway between the umbilicus and the symphysis pubis it blends with the posterior lamella of the internal oblique aponeurosis, medial to the border of the rectus, and it takes part, therefore, in the formation of the posterior part of the sheath of the rectus. Below halfway between the umbilicus and the symphysis pubis it passes in front of the rectus and blends with the aponeurosis of the external and internal oblique muscles to form the lower part of the anterior wall of the sheath.

In the area lateral to the sheath of the rectus abdominis the only structures which now separate the dissector from the cavity of the abdomen are, the transversalis fascia, the extra-peritoneal fat, and the peritoneum. Do not attempt to reflect the transversalis fascia as a whole, but make an incision through it, near the margin of the ribs or near the iliac crest, to display the extra-peritoneal fat, then scrape away the fat to display the peritoneum ; finally, make a small incision through the peritoneum and insert the finger through it into the abdomen, but do not enlarge the opening, and do not disturb the contents of the abdomen.

If the subject is a male the dissectors should now examine the scrotum, and after they have gained a general idea of its constituent parts they should proceed to dissect it.

Scrotum.—The scrotum is a pendulous purse-like arrangement of the skin and superficial fascia for the lodgment of the testes. The skin composing it is of a dark colour and rugose, and is traversed, along the middle line, by a *median raphe* or ridge, which indicates its bilateral character.

The superficial fascia possesses certain characters peculiar to itself. It has a ruddy colour, and is totally devoid of fat. The ruddy tint is due to the presence of involuntary muscular fibres which take the place of the fat, and constitute what is called the *dartos muscle.* The rugosity of the scrotal skin is maintained by the tonic contraction of the fibres of the dartos muscle. But, further, the dartos muscle forms an imperfect septum or partition, which divides the interior of the scrotum into two chambers—one for each testis. The points mentioned in connection with the construction of the scrotum have all, to a certain degree, been noted in the dissection of the perineum.

The two scrotal tunics, however, are not the only coverings of the testis. Each constituent of the abdominal wall has been seen to contribute an investment to the spermatic cord, and each in turn is continued down so as to clothe the testis. Presuming, then, that the skin and superficial fascia are reflected, the testis and cord within the scrotum will still be found to be invested by:—

1. The external spermatic fascia, from the aponeurosis of the external oblique.
2. The cremasteric fascia—the muscular element of which is derived partly from the internal oblique.
3. The internal spermatic fascia, from the fascia transversalis.

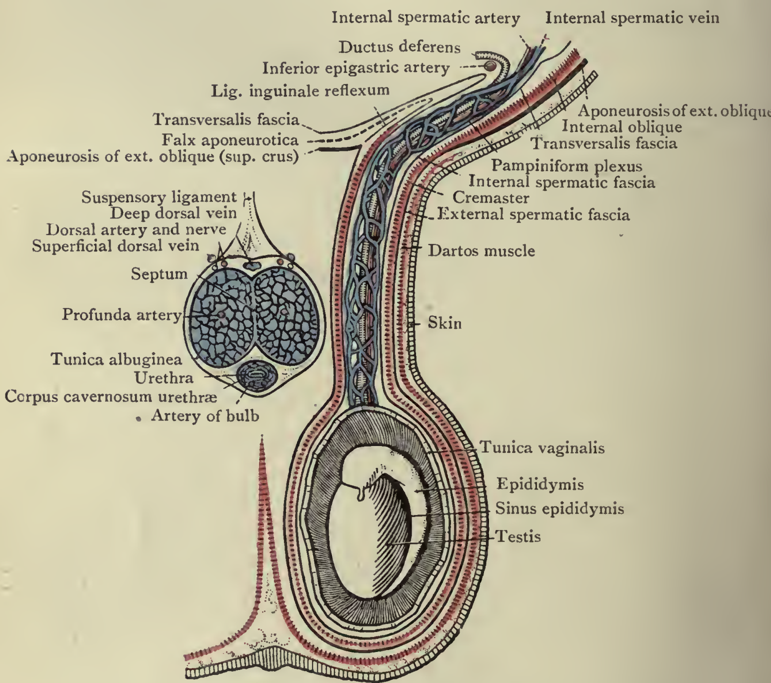


FIG. 102.—Diagram of a Frontal Section through the Penis and the Left Part of the Scrotum.

Within the skin and the dartos muscle, and the three coverings derived from the three layers of the wall of the abdomen, there is an additional covering of the testis called the *tunica vaginalis* (Figs. 102, 105).

The tunica vaginalis is an invaginated serous sac, derived from the lower end of a tube-like process of the peritoneum which descended into the scrotum in the early stages of development, and at that time its cavity was continuous with the cavity of the peritoneum. In the later stages of intra-uterine life the upper part of the process is obliterated, and the lower part remains as the tunica vaginalis, which surrounds the testicle everywhere except along its posterior border.

From the above description the student will understand that there is only *one* tunic common to both testes, viz., the integument; that the superficial fascia and dartos, forming the dartos tunic, and the investments derived from the abdominal wall, constitute special tunics for each testis.

Dissection.—In cases of old inguinal herniæ where the various layers covering the spermatic cord have become thickened, they can be separated and displayed to advantage, but in an ordinary case the student will find that whilst the skin, the dartos, and the tunica vaginalis are readily identified, the external spermatic fascia, the cremasteric fascia, and the internal spermatic fascia are less easily defined, and a satisfactory demonstration of them is difficult. Nevertheless the attempt should be made, and if the steps to be described are followed an excellent demonstration of the constituent parts of the spermatic cord will be obtained.

On the left side make an incision through the skin of the antero-lateral aspect of the scrotum, from the region of the subcutaneous inguinal ring to the lower end of the scrotum; then reflect the medial part of the divided skin towards the median plane. Remember that the superficial fibres of the dartos are attached to the skin, and therefore keep the edge of the scalpel playing strictly against the skin as the reflection proceeds. Carry the reflection beyond the median plane to demonstrate the fact that the skin forms a common sheath for both testicles, and does not send a deep lamella between them. When the skin is reflected the yellowish-pink layer of dartos tissue is obvious. Make an incision through it similar to the incision through the skin and reflect the medial part towards the median plane. As the median plane is reached a layer of the deep part of the dartos will be found extending upwards as a septum between the testicles. The dartos therefore forms a covering for each testicle, but the covering is incomplete, for the septum of the dartos is incomplete above. The layer of somewhat loose areolar tissue exposed by the reflection of the dartos is the external spermatic fascia. With the handle of the scalpel and the fingers separate it from the deep surface of the dartos. Begin the separation at the lower end of the scrotum and proceed upwards to the subcutaneous inguinal ring. When the separation is completed, the testicle and the spermatic cord with their remaining coverings are free. Examine now the extra-peritoneal fatty tissue which lies behind the abdominal inguinal ring. Note that a process of this tissue is prolonged downwards with the cord. Now, with the handle of the knife, gently separate the extra-peritoneal fat from the subjacent peritoneum. Behind the abdominal inguinal ring the peritoneum shows a slight bulging forwards, and a slender fibrous band may be detected passing into the cord from the most

prominent part of this bulging. The fibrous cord is the remains of the tube of peritoneum which, in the fœtus, connected the serous investment of the testis (the tunica vaginalis) with the general peritoneal lining of the abdomen. In some cases it may be traced as far as the testis, but more commonly it extends down the cord only for a short distance ; indeed, it is frequently absent.

To obtain a proper conception of the fibrous thread, it is necessary that the student should understand that neither the testis nor the tunica vaginalis are developed in the scrotum. In the early months of fœtal life the rudimentary scrotum contains neither tunica vaginalis nor testis; the testis lies on the posterior wall of the abdomen, projecting forwards into the great serous cavity of the abdomen, which is called the peritoneal cavity. The wall of the peritoneal cavity is formed by a membrane called the peritoneum, and the inner surface of the membrane is lined with a layer of flat epithelium —peritoneal epithelium. The peritoneum which is in contact, externally, with the wall of the abdomen is called the *parietal peritoneum*; but here and there the posterior wall of the peritoneal sac is invaginated by one or other of the abdominal viscera. When the invaginating viscus carries forward more peritoneum than is necessary to cover its surfaces, the excess of peritoneum forms a fold which connects the viscus with the posterior wall of the abdomen; such folds are called *mesenteries* and they connect the peritoneum covering the invaginating viscus, which is termed the *visceral peritoneum*, with the parietal peritoneum lining the inner surface of the abdominal wall. The testis is developed in the lumbar region; and it projects forwards into the peritoneal cavity, covered with a layer of epithelium which is continuous with the peritoneal epithelium. It also invaginates a portion of the wall of the peritoneal sac and so produces a mesentery connecting the testis and the epithelium which covers its surface with the parietal peritoneum; this mesentery is called the *mesorchium*.

The testis and its mesorchium gradually descend in the wall of the peritoneal sac to the inguinal region; and, at the same time, a diverticulum of peritoneum, the *processus vaginalis*, is projected through the inguinal portion of the abdominal wall into the scrotum, producing by its passage the inguinal canal, and prolonging the cavity of the peritoneum into the scrotum. During the latter part of the seventh and the early part of the eighth month of fœtal life the testis, with its epithelium and its mesorchium, descends along the posterior wall of this diverticulum, and during the ninth month it comes to rest near the lower end of the scrotum, where it projects forwards in the posterior wall of the lower part of the processus vaginalis. In the meantime, the cavity of the upper part of the processus vaginalis disappears and its peritoneal

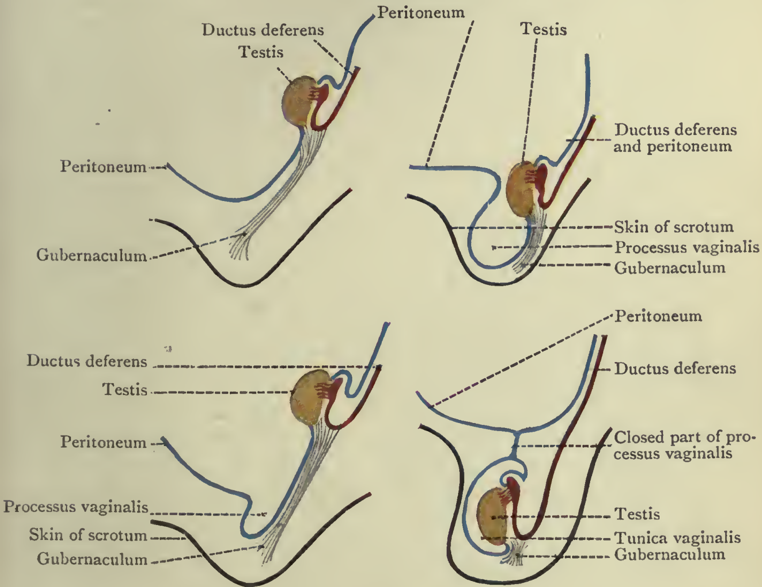


FIG. 103.—Diagrams illustrating the Descent of the Testis and the Derivation of the Tunica Vaginalis from the peritoneal lining of the abdominal cavity.

wall forms a solid fibrous cord (*Rudimentum processus vaginalis*). The lower part of the sac, thus cut off, is the tunica vaginalis of the testis. Its cavity is now entirely separated from the cavity of the peritoneum, but its wall is still connected with the peritoneum, for a longer or shorter time, by the fibrous cord which is the remains of the upper part of the processus vaginalis. In most cases, however, that cord undergoes atrophy, from below upwards, and in many cases, as already mentioned, it entirely disappears.

The orifice of communication between the processus vaginalis and the peritoneal cavity is closed usually before birth; and the cavity of the upper portion of the process, from the abdominal inguinal ring to the persistent tunica vaginalis, is generally obliterated during the first month of extra-uterine life.

The cause of the descent of the processus vaginalis and the testis is still a subject of dispute. It has been suggested:—(1) that it is due to different growth energy in adjacent parts; (2) to traction from below, produced by a musculo-fibrous cord, the *gubernaculum of the testis*, which grows through the inguinal part of the abdominal wall and is attached to the interior of the scrotum, whilst, above, it is attached to the testis and the adjacent peritoneum; (3) to the action of intra-abdominal pressure, tending to displace the testis downwards.

Funiculus Spermaticus.—The spermatic cord is formed by the association together of certain blood-vessels, nerves, and lymph vessels, along with the ductus deferens, all of which are proceeding to or passing from the testis. The structures come together at the abdominal inguinal ring, and that may be taken as the point at which the cord begins. The cord has already been traced in its course through the inguinal canal, and has been observed to issue from the canal through the subcutaneous inguinal ring. It is now seen as it lies within the scrotum suspending the testis.

Constituent Parts of the Spermatic Cord.—The following are the structures which form the spermatic cord:—

1. The ductus deferens (O.T. vas deferens).
2. Blood-vessels.
   - Arteries.
     - The internal spermatic.
     - The external spermatic.
     - The artery to the ductus deferens.
   - Veins.
     - The pampiniform plexus of veins.
3. Lymph vessels.
4. Nerves.
   - External spermatic.
   - Sympathetic twigs.
5. A fibrous strand.

The constituent parts are all held together by loose areolar tissue which intervenes between them, and also by the investments which are given to the cord by the abdominal wall.

Dissection.—The dissection of the sheaths and the constituent parts of the extra-abdominal part of the spermatic cord is best done under water. Divide the cord at the abdominal inguinal ring; place the cord and the testicle with their coverings in a cork-lined tray; fasten the testicle and the cord to the cork with pins, and fill the tray with water. Divide the external spermatic fascia longitudinally and turn it aside; next make a longitudinal incision through the cremasteric fascia along the cord and reflect the divided fascia downwards over the testicle. The cremasteric fascia consists of strands of muscle intermingled with fibrous tissue. Then deal in a similar manner with the internal spermatic fascia, and, as the testicle is approached, be careful not to injure the tunica vaginalis. After the internal spermatic fascia has been reflected, dissect out the constituent parts of the spermatic cord from the areolar tissue in which they are embedded, and by which they are still surrounded. In the anterior part of the cord lie the anterior veins of the pampiniform plexus and the internal spermatic artery. In the posterior part are the posterior veins of the pampiniform plexus and between the two groups of veins is the ductus deferens accompanied by its artery.

Ductus Deferens (O.T. **Vas Deferens**).—The ductus deferens is the duct through which the spermatozoa pass from the testicle to the urethra. It is, therefore, the most important constituent of the cord. It can always be distinguished, both in the living and the dead body, by the hard, firm, cord-like sensation which it gives when the spermatic cord is held between the index finger and the thumb. It commences at the lower end of the testicle, and ascends, behind the testicle, to the spermatic cord. In the cord it lies posteriorly, behind the internal spermatic artery and the larger anterior group of veins of the pampiniform plexus. At the subcutaneous inguinal ring it enters the inguinal canal and passes through the canal, still accompanied by the veins and arteries. At the abdominal inguinal ring it leaves the internal spermatic artery, and the internal spermatic vein in which the pampiniform plexus has ended, and, accompanied by the artery to the ductus deferens, it hooks round the inferior epigastric artery and passes into the pelvis. Its pelvic course is described on p. 451.

The *artery to the ductus deferens* is a small branch from a superior vesical. It passes along the duct to the testis.

The *external spermatic artery* is a branch of the inferior epigastric; it has already been seen entering the cremaster muscle. The *external spermatic nerve*, a branch of the genitofemoral nerve, has a similar destination. It has been displayed in a previous stage of the dissection.

The *internal spermatic artery* arises, within the abdomen, from the front of the aorta; it enters the cord at the abdominal inguinal ring, and proceeds to the testis, into the posterior border of which it sinks, after dividing into several smaller twigs. The *testicular veins* issue from the testis at its posterior border, and, as they pass upwards, they form, in the cord, a bulky plexus, which is termed the *pampiniform plexus.* A single vessel, the *spermatic vein*, issues from the plexus, and enters the abdomen through the abdominal inguinal ring. On the right side it pours its blood into the inferior vena cava; on the left side it joins the left renal vein.

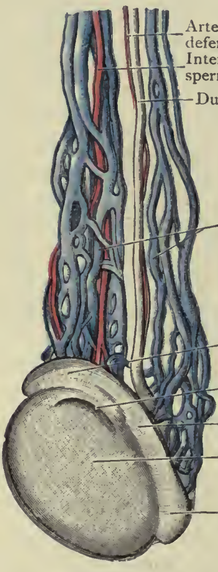


FIG. 104.—Dissection of the Left Spermatic Cord to show its constituent parts. (From Waldeyer, modified.)

The *sympathetic filaments* extend downwards upon the internal spermatic artery. They come from the renal and aortic plexuses.

The *spermatic lymph vessels* enter the abdomen through the abdominal inguinal ring, and join the lumbar glands.

Dissection. — The tunica vaginalis has still to be examined. It is an invaginated sac which surrounds both the testicle and the epididymis, which lies at the lateral side of the posterior part of the testicle. To demonstrate the extent of the sac make a small incision through the anterior part of its wall; then introduce a blowpipe through the incision and distend the cavity. When the distension is completed it will be seen that the sac is much more extensive than the structures it surrounds. It envelops them everywhere except posteriorly, passes upwards beyond them, on the front of the lower part of the spermatic cord, and also downwards below them for a short distance. Now, with the aid of scissors open the sac by enlarging the incision through which the blowpipe was passed, both upwards and downwards, to the upper and lower limits of the cavity. When the cavity has been laid open the difference between the inner and outer surfaces of the tunica vaginalis will be obvious. The outer surface which was connected with the inner surface of the internal spermatic fascia, by loose areolar tissue, is relatively rough and flocculent, but the inner surface is smooth and glistening.

Tunica Vaginalis.—The tunica vaginalis is an invaginated serous sac. The uninvaginated portion which lies in relation with the inner surface of the internal spermatic fascia is called the *parietal* or *scrotal* portion. The inner or invaginated part is the *visceral* or *testicular* portion; it covers the

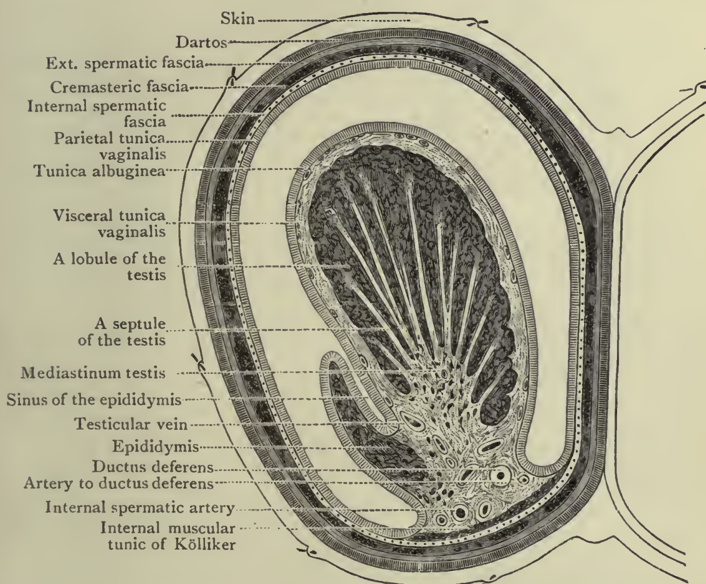


FIG. 105.—Transverse section through the left side of the Scrotum and the Left Testis, seen from above. The sac of the tunica vaginalis is represented in a distended condition.

surfaces and anterior borders of the testicle and epididymis, and at their posterior borders it is continuous with the parietal portion. In ordinary circumstances the parietal and visceral layers are separated from one another only by a thin layer of fluid, which diminishes friction when the layers move over one another, and the cavity of the sac is merely a potential cavity; but in some abnormal circumstances the fluid increases in quantity, the walls of the sac are forced apart, and the condition called hydrocele is produced.

On the lateral side of the testicle a portion of the cavity projects backwards between the testicle and the medial face of the epididymis; it is called *the sinus of the epididymis* (Figs. 102, 105).

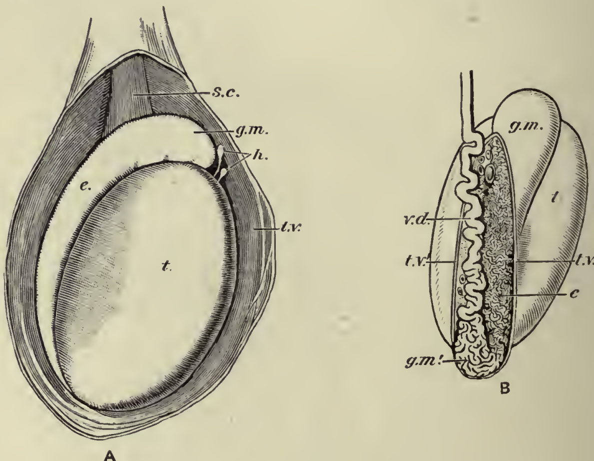


FIG. 106.

A. The Right Testis and Epididymis within the tunica vaginalis. (A. F. Dixon.)

s.c. Spermatic cord.
g.m. Caput epididymidis.
e. Corpus epididymidis.
t. Testis.
h. Appendices testis (Morgagni).
t.v. Tunica vaginalis.

B. The Right Testis and Epididymis seen from behind, after removal of the parietal part of the tunica vaginalis. (A. F. Dixon.)

t.v'. Cut edge of tunica vaginalis along the line where the *parietal part* becomes continuous with the *visceral part.*
v.d. Ductus deferens.
g.m'. Cauda epididymidis.

Testis.—Each testicle invaginates the posterior wall of the corresponding tunica vaginalis. It is an oval body with flattened sides and it varies considerably in size, but averages about 38 mm. (one and a half inches) in length, 25 mm. (one inch) in antero-posterior diameter, and somewhat less than that from side to side.

It is free, except above and behind where it is connected with the epididymis and is covered everywhere, except along its posterior border, by the visceral layer of the tunica vaginalis. Its efferent ducts issue from its upper end and enter the epididymis, whilst its vessels and nerves pass through its posterior border. It lies somewhat obliquely in the scrotum, its superior extremity being directed forwards and upwards, and the left testis, as a rule, hangs at a lower level than the right. Attached to the upper part of the anterior border of the testis, in front of the head of the epididymis one or two small pear-shaped bodies may be found. They are the *appendices testis*, and are remnants of embryonic structures. One appendix is, usually, stalked, the other is smaller and sessile.

Epididymis.—The epididymis is a comma-shaped structure which lies along the lateral side of the posterior border of the testis from its upper to its lower end. The enlarged upper end of the epididymis is the *caput epididymidis*; the thin lower end is the *cauda epididymidis*, and the intervening part is the *corpus epididymidis*.

The caput epididymidis surmounts the superior extremity of the testis like a helmet, and is attached to it both by the visceral tunica vaginalis, which is continued over it, and also by the *ductuli efferentes*, which pass from the testis into the epididymis. The *cauda epididymidis* is fixed to the back of the testis merely by the visceral tunica vaginalis and some intervening areolar tissue. The *body of the epididymis* is separated from the body of the testis by an involution of the serous covering which forms the wall of the *sinus epididymidis*.

The *ductus deferens* emerges from the inferior extremity of the tail of the epididymis and then passes upwards, upon the posterior margin of the testis and on the medial side of the body and head of the epididymis. By this relation, the side to which a given testis belongs can be readily detected.

The vessels of the testis and the epididymis enter and emerge from their posterior margins.

Dissection.—Some of the main facts relating to the structure of the testis may be learned by a careful naked-eye examination of its different parts. For that purpose place it in a cork-lined tray and dissect it under water. Having fixed it to the bottom of the tray, with pins, begin by tracing the blood-vessels into the gland. As that is done, a quantity of involuntary muscular tissue spread over the posterior border of the testis and the epididymis becomes apparent. It is the *inner muscular tunic* *of Kölliker*. Now free the tail and body of the epididymis from the back of the gland by cutting the serous covering as it passes from one to the other, and breaking through the fibrous tissue which intervenes between the tail and the lower part of the testis. Do not interfere with the head of the epididymis. When the body and tail of the epididymis are turned aside, the testis should be divided transversely, with a sharp knife, about its middle, into an upper and a lower portion.

Structure of the Testis.—The cut surface of the lower part of the testis should now be studied. The dense, tough fibrous coat which envelops it, under cover of the visceral layer of the tunica vaginalis, is the *tunica albuginea*.

At the posterior border of the testis the tunica albuginea forms a thickened ridge, called the *mediastinum testis*, which projects forwards into the interior of the testis.

The mediastinum testis extends along the whole length of the posterior border of the gland. It is traversed by the arteries, veins, and lymph vessels of the testis, and, in addition, it is tunnelled by a plexus of intercommunicating seminal channels which form, collectively, the *rete testis*.

From the front and sides of the mediastinum testis radiating fibrous strands pass through the substance of the testis. They are the cut margins of incomplete fibrous septula which extend towards the deep surface of other parts of the tunica albuginea and become connected with them (Figs. 105, 107). By means of the partitions, the space enclosed by the tunica albuginea becomes broken up into a large number of partially separated lobules or compartments, two to three hundred in number. The fibrous framework of the testis consists therefore of the tunica albuginea with the mediastinum testis and the septula.

The blood-vessels have a very definite arrangement with reference to fibrous framework. After they have passed through the mediastinum they spread out upon the surfaces of the fibrous septula and on the deep surface of the tunica albuginea. The vascular mesh-work thus formed is sometimes called the *tunica vasculosa*.

The proper glandular substance of the testis is lodged within the compartments described above. It consists of four to six hundred fine hair-like tubes, termed the *contorted seminiferous tubules*, each of which is about 60 cm. (two feet) long. Two or more occupy each compartment, and constitute what is called a *testicular lobule*. In each testicular lobule the tubes are coiled and convoluted to an extraordinary degree, and the coils are surrounded and bound together by connective tissue, which contains a large number of peculiar cells known as the *interstitial cells* of the testicle.

Approaching the mediastinum testis, the tubuli seminiferi contorti join each other at acute angles and form a smaller number of tubes, which finally become straight and considerably reduced in diameter. These are called the *tubuli seminiferi recti.* They enter the mediastinum and join the *rete testis.*

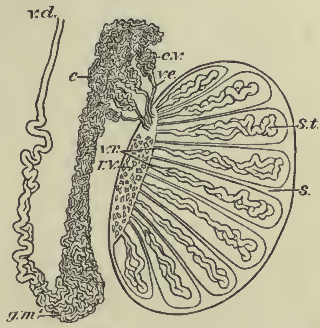


FIG. 107.—Diagram illustrating the Structure of the Testis. (A. F. Dixon.)

v.d. Ductus deferens.
g.m'. Cauda epididymidis.
c. Caput epididymidis.
c.v. Lobuli epididymidis.
v.e. Ductuli efferentes testis.
v.r. Tubuli seminiferi recti.
r.v. Rete testis.
s.t. Contorted seminiferous tubule.
s. Septula testis.

Dissection.—Attempt to unravel some of the tubuli of the testis, under water, with the aid of forceps and a probe. It will not be possible, under ordinary circumstances, to open them out fully, but a sufficiently good demonstration of their general arrangement may be made. Afterwards the tubuli should be removed from the lower part of the testis, by the use of the forceps, aided by a stream of water. A good view of the fibrous framework of the testis will then be obtained.

The dissector must next endeavour to ascertain the manner in which the secretion of the testis passes from the rete testis into the epididymis. For that purpose the upper part of the testis, with the attached epididymis, must be examined. Gently raise the caput epididymidis from the surface of the testis, by dividing the visceral part of the tunica vaginalis which binds them together, and carefully break down the intervening connective tissue. Under favourable circumstances the *ductuli efferentes*, which pass from the rete testis to the tube of the epididymis, may be seen.

Structure of the Epididymis.—The *ductuli efferentes testis* are fifteen to twenty delicate ducts. They leave the upper part of the rete testis, and pass into the caput epididymidis. In the caput the ductuli efferentes become coiled and form a series of small conical masses, called the *lobuli epididymidis.* Ultimately the efferent ducts open into a single convoluted canal, termed the *ductus epididymidis.* The head of the epididymis is thus composed of the lobules of the epididymis and part of the coiled duct of the epididymis embedded in areolar tissue. The body and tail of the epididymis are formed of the continuation of the same canal, coiled and convoluted upon itself to a remarkable degree.

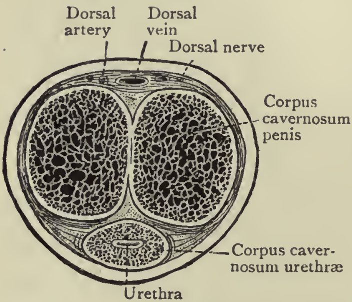


FIG. 108.—Transverse section through the body of the Penis.

The intricacy of its flexuosities will be better understood by simply stating that if the tube were completely opened out it would be found to measure 6 meters (twenty feet) or more. At the lower end of the tail of the epididymis the duct of the epididymis becomes continuous with the ductus deferens.

***Dissection.*—The dissector should endeavour to unravel a part of the ductus epididymidis. The coils are held together by areolar tissue and the dissection is very tedious.**

Penis.—The penis was studied, to a certain extent, when the perineum was dissected and its two main constituent parts — the *corpus cavernosum penis* and the *corpus cavernosum urethræ* —were partially examined. It was noted also, at that time, that the corpus cavernosum penis divides, posteriorly, into the two crura of the penis, each of which is attached to the corresponding side of the pubic arch. Anteriorly the corpus cavernosum penis ends in a blunt rounded extremity which is covered by the glans penis (Figs. 82, 109).

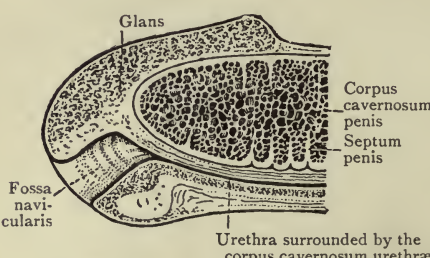


FIG. 109.—Median section through the terminal part of the Penis.

The anterior and posterior parts of the corpus cavernosum urethræ are both expanded. The posterior expanded part forms the *bulb of the urethra*, which is attached to the median part of the inferior fascia of the urogenital diaphragm. The anterior expanded portion forms the *glans penis*, which forms a cap over the blunt anterior end of the corpus cavernosum penis (Fig. 109).

The glans penis is conical in shape and the projecting margin of its base is called the *corona glandis*.

The urethra traverses the whole length of the corpus cavernosum urethræ, entering the bulb, from above, at the inferior fascia of the urogenital diaphragm, and terminating at the extremity of the glans as a vertical fissure, called the *orificium urethræ externum* (O.T. *meatus urinarius*).

The *integument of the penis* is remarkable for its great delicacy and elasticity, and the absence of hairs. It has a brownish tint, and is freely movable over the organ. At the glans the skin leaves the body of the penis, and, passing for a variable distance over the glans, is folded back upon itself so as to form the *prepuce* (Figs. 85, 113). The deep layer of the prepuce reaches the penis again behind the corona glandis, and is then reflected forwards over the glans to become continuous with the mucous membrane of the urethra at the external urethral orifice. A slight fold will be observed on the under surface of the glans, extending from the lower angle of the external orifice to the prepuce; this is the *frenulum preputii*.

Dissection.—Make a longitudinal incision along the dorsum of the penis, from the front of the symphysis pubis to the extremity of the prepuce, and reflect the skin to each side. The superficial fascia, which is thus exposed, consists of loose areolar tissue devoid of fat. Next clean the suspensory ligament of the penis (see p. 200), which descends from the front of the symphysis, and note that, as it reaches the dorsum of the body of the penis, it splits into right and left layers which fuse with the deep fascia at the sides of the penis. After the suspensory ligament is displayed find the superficial dorsal vein which runs backwards, in the superficial fascia, in the median plane. It ends posteriorly in the superficial external pudendal vein of one or both sides. Now clean away the superficial fascia, and expose the deep fascia. It forms a fibrous envelope for the body of the penis, enclosing both the corpus cavernosum penis and the corpus cavernosum urethræ.

After the deep fascia has been examined divide it, along the median line, on the dorsum of the penis. Immediately beneath it, in the median plane, find the deep dorsal vein. Clean the deep vein and note that, at the symphysis, it passes backwards, between the two laminæ of the suspensory ligament, to join the pudendal plexus. Between the laminæ of the suspensory ligament on each side of the deep dorsal vein find the dorsal arteries and nerves of the penis and trace them forwards towards the glans.

Suspensory Ligament of the Penis. — The suspensory ligament of the penis is a strong fibro-elastic band of a triangular shape. By its posterior border it is attached to the symphysis pubis. Towards the penis it separates into a right and a left lamella, which join the deep fascia of the body of the organ. Between the two lamellæ are placed the dorsal vessels and nerves (Figs. 92, 106).

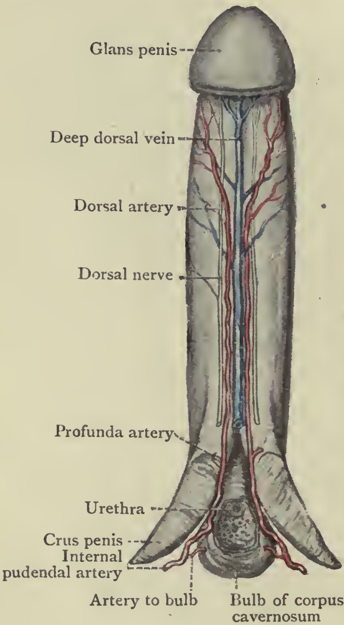


Fig. 110.—Upper Aspect of the Penis, showing the main Blood-Vessels and Nerves.

Dorsal Vessels and Nerves.—In the median line of the dorsum of the penis, in the superficial fascia, lies the *superficial dorsal vein*, and, under cover of the deep fascia, in the groove which extends along the middle line of the dorsum of the corpus cavernosum penis, the larger *deep dorsal vein* is situated. A short distance lateral to the deep dorsal vein are the *right and left dorsal arteries* and lateral to the arteries are the *dorsal nerves.* On the dorsum of the penis, therefore, there are two veins, superficial and deep; two arteries; and two nerves.

The *superficial dorsal vein* receives tributaries from the prepuce and terminates posteriorly in the superficial external pudendal veins.

The *deep dorsal vein* of the penis begins by the union of several twigs from the glans and prepuce. It extends backwards in the middle line, passes between the two layers of the suspensory ligament, and enters the pelvis after passing below the arcuate ligament of the pubis. It ends by joining the pudendal plexus of veins.

The *dorsal arteries* are terminal twigs of the internal pudendal arteries. They pass forward between the two layers of the suspensory ligament, and, continuing their course, on the dorsum of the penis, they terminate in branches to the glans penis.

The *dorsal nerves* are branches of the pudendal nerve. They accompany the arteries, and end in fine twigs to the papillæ of the glans.

Dissection.—Make a transverse section through the corpora cavernosa of the penis and urethra, but leave the skin on the inferior surface undivided in order that the two segments of the divided organ may remain connected until the urethra has been examined at a later stage. After the section has been made examine the naked-eye structure of the divided parts.

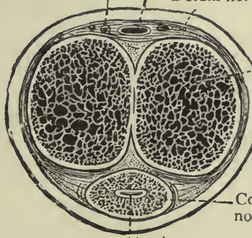


FIG. 111.—Transverse section through the body of the Penis.

Structure of the Corpus Cavernosum Penis.—The corpus cavernosum penis consists of a spongy tissue, called cavernous tissue, surrounded by a dense white fibrous sheath called the tunica albuginea of the corpus cavernosum, and it is divided into right and left halves by a median fibrous septum, *the septum penis.* The septum is incomplete; numerous vertical clefts, which are not recognisable in the transverse section, pass through it; the clefts may, however, be seen if the cavernous tissue is dissected away from the septum for a short distance on one or the other side. The fibrous stroma of the cavernous tissue is connected with the deep surface of the tunica albuginea. In the centre of each half of the divided corpus cavernosum penis the divided profunda artery may be seen.

Structure of the Corpus Cavernosum Urethræ.—The corpus cavernosum urethræ also consists of cavernous tissue, but the meshes of the cavernous reticulum are finer than those of the corpus cavernosum penis. The fibrous sheath which surrounds the corpus cavernosum urethræ is thinner and less dense than that of the corpus cavernosum penis.

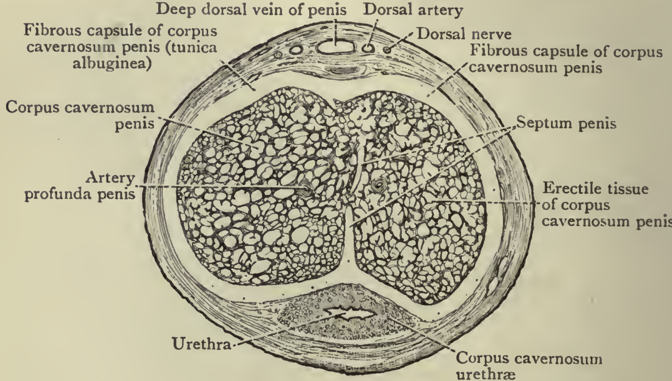


FIG. 112.—Transverse section through the anterior part of the body of the Penis.

In the centre of the corpus cavernosum urethræ the divided urethra will be seen and, in a well-injected specimen, the

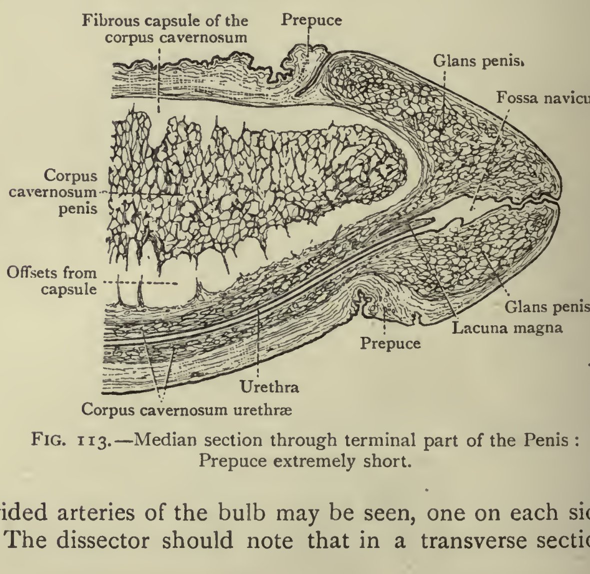


FIG. 113.—Median section through terminal part of the Penis: Prepuce extremely short.

divided arteries of the bulb may be seen, one on each side.

The dissector should note that in a transverse section of the penis six arteries may be met with. They are the two dorsal arteries, the two profunda arteries, and the two arteries to the bulb of the penis.

Trigonum Lumbale and Lumbar Fascia.

On the sixth day after the body was placed on its back it will be turned upon its face, with blocks supporting the thorax and pelvis, and in that position it will remain for five days. At the end of the first or the beginning of the second day of the period, after the dissector of the upper extremity has cleaned the latissimus dorsi, the dissector of the abdomen must take the opportunity of examining the posterior border of the external oblique. As the posterior border of the muscle passes from the last rib to the external lip of the iliac crest it is quite free, and, in many cases, there is a small triangular interval between it and the lower part of the lateral border of the latissimus dorsi in which the fibres of the more deeply situated internal oblique can be seen. The triangle is the *trigonum lumbale* (*Petiti*). It is a comparatively weak region of the abdominal wall, and in some rare cases hernia of the abdominal contents occurs through it. Not uncommonly, however, the lateral border of the latissimus dorsi overlaps the posterior border of the external oblique, and in those cases the trigonum lumbale does not exist.

On the third day, after the dissector of the upper extremity has reflected the muscles which connect the upper extremity with the trunk on the posterior aspect, the dissector of the abdomen, in association with the dissector of the head and neck, should examine the lumbar fascia and the lumbar origins of the internal oblique and the transversus abdominis muscles.

The lumbar fascia is a portion of the lumbo-dorsal fascia which binds down the deep muscles of the back at the sides of the spines of the vertebrae. In the thoracic region it is a thin transparent lamina which extends from the spines of the vertebræ to the angles of the ribs. At the upper end of the thoracic region it disappears into the neck under cover of the serratus posterior superior. In the lumbar region it becomes much stronger and more complicated. Above, it is continuous with the thoracic portion of the fascia and is attached to the last rib. Medially, it is attached to the tips of the spines and transverse processes, and to the fronts of the transverse processes of the lumbar vertebræ; laterally, it is connected with the transversus abdominis and the internal oblique, and, below, it is closely attached to the posterior part of the external lip of the iliac crest. In the pelvic region it is attached to the spines of the sacrum, and to the back of the lower part of the sacrum and to the back of the coccyx. In the lumbar region its posterior lamella covers the rounded column of the sacro-spinalis muscle, and to this

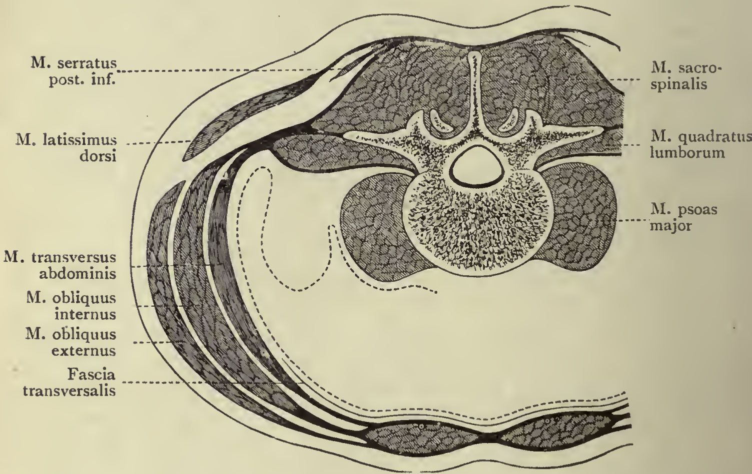


FIG. 114.—Lumbar fascia and sheath of Rectus abdominis. The dotted line represents the Peritoneum.

part the remains of the origin of the latissimus dorsi and the serratus posterior inferior will be found attached.

Dissection.—Clear away the remains of the latissimus dorsi and clean the serratus posterior inferior, which extends upwards and laterally to its attachment to the lower four ribs. It must be cut through at right angles to its fibres and turned aside, its nerves of supply, from the anterior branches of the lower thoracic nerves, being sought for on its deep surface. The remains of its origin from the lumbar fascia must be cleared away and then a vertical incision must be made through the fascia, midway between the medial and lateral borders of the rounded mass of the sacro-spinalis muscle; at each end of the longitudinal incision a transverse incision must be made, one just below the last rib and the other just above the iliac crest. The transverse incisions should commence at the median plane and should not extend beyond the lateral margin of the mass of sacro-spinalis muscle. The medial part of the divided fascia must be turned to the median plane and its attachments to the tips of the spines verified. The lateral part should be pulled laterally, and at the lateral border of the mass of the sacro-spinalis it will be found to blend with a deeper, middle, layer. Push the sacro-spinalis medially and follow the middle lamella to its attachment to the tips of the transverse processes. The dissectors should then note that the upper fibres of origin of the internal oblique spring from the lumbar fascia just lateral to the line where the middle and posterior lamellæ of the fascia blend. There is still, however, another lamella of the lumbar fascia—the anterior lamella. To display that part the dissector must divide the middle lamella vertically, close to its attachments to the tips of the transverse process, and transversely along the line of its attachment to the iliac crest. The middle lamella can then be turned laterally, and the posterior surface of the quadratus lumborum will be brought into view. When the lateral border of the quadratus lumborum muscle is displaced towards the median plane the anterior lamella of the lumbar fascia will be exposed. The dissector should place his finger upon its surface and trace it medially and laterally. Medially he will be able to follow it to, or to within a short distance of, the roots of the transverse processes of the vertebræ, and laterally he will find that it joins the remainder of the fascia some distance lateral to the union of the posterior and middle lamellæ. He must note, further, that, beyond the union of the three lamellæ, the lumbar fascia is continued into the transversus abdominis, and thus it is, through the lumbar fascia, that the transversus obtains its origin from the tips of the spines and transverse processes, and from the fronts of the transverse processes of the lumbar vertebræ. When the dissector has satisfied himself regarding the lamellæ of the lumbar fascia and their relation to the internal oblique and the transversus abdominis, he should carefully divide the anterior lamella longitudinally, and, introducing his finger through the incision, into the extra-peritoneal fatty tissue, he should scrape away the latter until he exposes the lower part of the kidney, below the level of the last rib; and the adjacent part of the colon, which lies along the lower and lateral part of the kidney. After that has been done the dissector of the abdomen ceases work till the body is re-turned, when he will re-examine the anatomy of the inguinal region in association with the formation of hernia, and afterwards proceed to the investigation of the abdominal cavity and its contents.

HERNIA.

The anatomy of the abdominal wall, in the regions where hernia most frequently occurs, is of such great importance to the surgeon that special attention must be paid to it by the dissector.

Hernia is the term applied to the abnormal protrusion, through the wall of the abdomen, of a viscus, or a part of a viscus, or of a part of a peritoneal fold which supports or is attached to a viscus.

It occurs most commonly where the peritoneal sac, or a diverticulum of the peritoneal sac, was prolonged through the abdominal wall at some period of intra-uterine development. The two situations in which such prolongations are always present are the inguinal region and the umbilicus; and it is stated that a small diverticulum is almost always met with in the subinguinal region, dipping into the mouth of the femoral canal of the femoral sheath. Those three regions, therefore, are the situations in which hernia is most often met with, and it is asserted that the most important factor in the production of hernia is the presence of a more or less definite persisting diverticulum of the peritoneum.

The diverticulum which existed in the inguinal region was the processus vaginalis described on pp. 234, 235. That diverticulum passed obliquely through the wall of the abdomen, producing the inguinal canal; and, although the diverticulum disappears, the canal made by its passage may be looked upon, to a certain extent, as a source of weakness to the part of the wall through which it runs. The weakness, however, is more apparent than real, for the canal is so oblique in the adult that its abdominal opening, *the abdominal inguinal ring*, is one and a half inches distant from its superficial opening, the *subcutaneous inguinal ring*; the opening is therefore valvular, and the intra-abdominal pressure, forcing the posterior wall against the anterior wall, tends to close the canal; moreover, the constituent parts of the anterior and posterior walls are so arranged that weakness of one wall is compensated for by strength in the opposite wall. The dissector should now proceed to demonstrate the truth of these statements by making a special dissection of the inguinal region on the left side of the body, which has been kept intact for the purpose.

Dissection.—Begin by reflecting the aponeurosis of the external oblique. Make a vertical incision through it, parallel to the lateral border of the rectus abdominis, and carry the incision downwards on the medial side of the superior crus of the subcutaneous inguinal ring. The aponeurosis can then be thrown downwards and laterally; and, at the same time, the subcutaneous ring is preserved. The internal oblique, the cremaster, and falx inguinalis should now be cleaned, and their precise relations to the spermatic cord studied. Notice that the fleshy lower border of the internal oblique overlaps the lateral part of the cord, whilst, towards the outlet of the inguinal canal, the falx inguinalis lies behind the cord. Next, replace the aponeurosis of the external oblique, and introduce the point of the forefinger into the subcutaneous ring and press directly backwards. Note that the finger rests either upon the lig. inguinale reflexum, which lies anterior to the falx inguinalis, or, if the reflex inguinal ligament is absent, upon the falx inguinalis itself; that, in fact, the ligament and the falx and the fascia transversalis intervene between the finger and the extra-peritoneal fatty tissue and the peritoneum. The lower part of the internal oblique muscle should now be separated from the transversalis by insinuating the handle of the knife between them. When that is done, divide the internal oblique close to the inguinal ligament, and throw it medially. At the same time, make a longitudinal incision through the cremaster muscle, and turn it aside from the surface of the cord.

All further dissection must be effected from the inside. Divide the abdominal wall horizontally, from side to side, at the level of the umbilicus. When the lower part is raised and its posterior aspect is examined three peritoneal folds are seen—the *plicæ umbilicales*—a median and two lateral. In the median fold lies the *middle umbilical ligament* or urachus, which descends from the umbilicus to the apex of the urinary bladder, and in each lateral fold is the obliterated portion of the umbilical branch of the hypogastric artery of the corresponding side. Each lateral fold, with the contained obliterated artery, descends from the umbilicus to the side of the bladder if the latter is distended, and to the side wall of the pelvis if the bladder is empty. The lower part of each lateral fold lies on the posterior surface of the abdominal wall, a short distance to the medial side of the abdominal inguinal ring. Still more lateral on each side, close to the abdominal inguinal ring, is another fold, caused by the inferior epigastric artery as it ascends to the posterior aspect of the rectus abdominis.

By means of the folds three fossæ are mapped out on each side of the middle line above the inguinal ligament; they are termed the *supravesical*, the *medial* and *lateral inguinal fossæ*, and they are regarded as determining, to some extent, hernial protrusions in the inguinal region. The supravesical fossa lies between the middle umbilical fold and the lateral umbilical fold; the subcutaneous inguinal ring is in front of its lower part, separated from it by the most medial part of the posterior wall of the inguinal canal. The medial inguinal fossa, narrow but frequently very deep, lies between the lateral umbilical fold and the fold containing the inferior epigastric artery. It is behind that part of the posterior wall of the inguinal canal which is formed by the transversalis fascia only. The lateral inguinal fossa lies to the lateral side of the fold formed by the inferior epigastric artery, and its lowest, medial, and deepest part corresponds with the abdominal inguinal ring.

Having determined these points, the dissector can proceed as follows:—Divide the lower part of the abdominal wall in a vertical direction along the linea alba, from the umbilicus to the pubes. Make the incision a little on one side of the middle umbilical ligament, and, when approaching the pubic symphysis, be careful not to injure the urinary bladder, which may project upwards above the symphysis. When the left flap is thrown downwards and laterally, it may be possible to detect the position of the abdominal inguinal ring, from the fact that in some cases the peritoneum is slightly dimpled into it. Now strip the peritoneum from the flap as far down as the inguinal ligament. That can be easily done with the fingers, as the connection of the peritoneum with the extra-peritoneal fatty tissue is very slight. Next, separate the extra-peritoneal fatty tissue from the fascia transversalis with the handle of the knife, proceeding with great care as the inguinal ligament is approached. The *abdominal inguinal ring*, or the inlet of the inguinal canal, is now seen from within. From that point of view the opening is more like a vertical slit in the fascia transversalis than a ring. Its lower and lateral margin will be seen to be specially strong and thick. Note the inferior epigastric artery passing upwards and medially, close to its medial margin. Further, observe the ductus deferens and the spermatic vessels entering it ; the former, as it disappears into the canal, hooks round the inferior epigastric artery. Introduce the tip of the little finger into the opening and push it gently along the line of the inguinal canal. Whilst the finger is still in the opening raise the flap of the abdominal wall and look at it from the front, a very striking demonstration of the internal spermatic fascia will then be obtained.

If the dissection is satisfactorily completed the student will be able to note that the canal possesses (1) an inlet, the abdominal inguinal ring ; (2) a floor formed laterally by the upper concave aspect of the inguinal ligament and medially by the lacunar ligament (Gimbernati) ; (3) an anterior wall ; (4) a posterior wall ; (5) an exit, the subcutaneous inguinal ring. A roof can scarcely be said to exist, for the anterior and posterior walls are in contact above, but arching above the lateral part of the canal are the lower borders of the internal oblique and the transversus abdominis. He should note also that there are three portions of the anterior wall and three portions of the posterior wall. At the medial end of the anterior wall lies the subcutaneous inguinal ring, covered, and to a certain extent closed, by the intercrural fibres descending on the spermatic cord. Immediately to the lateral side of the subcutaneous ring the anterior wall is formed by the aponeurosis of the external oblique only, and at its lateral end the anterior wall is composed of the external oblique aponeurosis and the lower fibres of the internal oblique muscle: the anterior wall, therefore, is weakest at its medial and strongest at its lateral exteemity. The posterior wall, on the contrary, is strongest at its medial end and weakest at its lateral end. At its medial end, behind the subcutaneous inguinal ring, it is three layers thick, the layers, from before backwards, being the lig. inguinale reflexum, the falx inguinalis, and the transversalis fascia. More laterally, opposite the region where the anterior wall consists of external oblique aponeurosis alone, the posterior wall is formed by the transversalis fascia and the

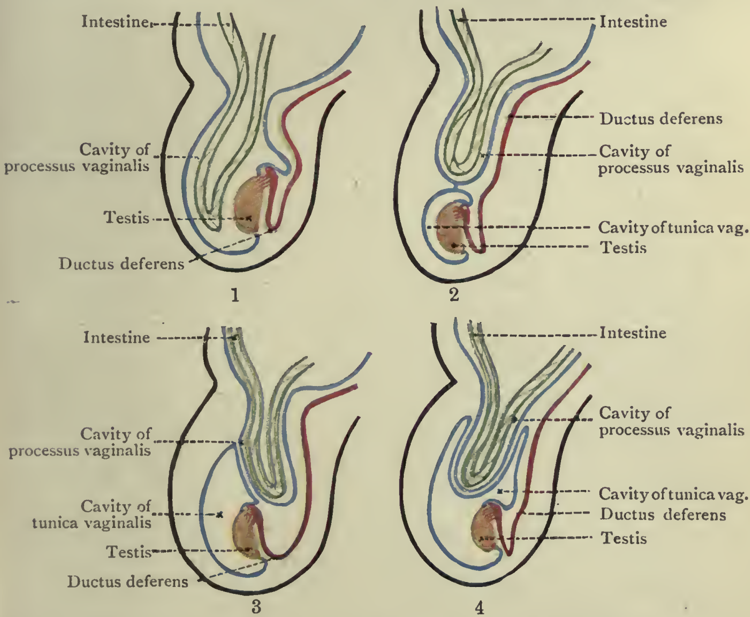


FIG. 115.—Diagram illustrating different forms of scrotal herniæ.

falx inguinalis, and still more laterally, where the anterior wall is formed by both external oblique aponeurosis and internal oblique muscle, the posterior wall is represented by transversalis fascia only. The walls of the canal are well adapted, therefore, to resist the effects of intra-abdominal pressure. The student must remember, however, that, for practical purposes, in association with the formation of hernia, the contents of the abdomen may be looked upon as being of a fluid or semifluid nature; consequently, if a portion of the abdominal contents happens to slip through the abdominal inguinal ring, into a persisting, though shrunken, processus vaginalis, the action of the abdominal pressure will, thenceforth, tend to distend the inguinal canal and force the abdominal contents further and further along it, until they eventually protrude through the subcutaneous inguinal ring. The coverings of such a hernia will naturally be the constituent parts of the abdominal wall in the inguinal region: that is, from within outwards, (1) peritoneum, (2) extra-peritoneal fat, (3) internal spermatic portion of transversalis fascia, (4) cremasteric fascia, (5) external spermatic fascia, (6) superficial fascia, and (7) skin. A hernia which travels obliquely through the abdominal wall, along the line of the inguinal canal, is called an *oblique inguinal hernia*, and, as the neck of the hernial sac lies to the lateral side of the inferior epigastric, it is called a *lateral inguinal hernia*. If the cavity of the persisting processus vaginalis, into which the hernia has passed, is still continuous with the cavity of the tunica vaginalis, the herniated viscus or peritoneal fold will enter the tunica vaginalis of the testis; but, if the cavity of the upper part of the processus vaginalis has been separated from that of the lower part by the formation of an oblique or transverse septum, the upper part of the processus, with its contained hernia, may be forced downwards either anterior or posterior to the lower part, or the lower end of the upper part may invaginate the upper end of the lower part. Herniæ differentiated from each other by the relationship which the upper part of the processus, containing the herniated viscus, bears to the lower part, the tunica vaginalis, are described by surgeons under special names which the student will find fully explained in manuals of surgery. There are, however, other forms of inguinal hernia which do not pass through the abdominal inguinal ring, but through the posterior wall of the canal, on the medial side of the inferior epigastric artery, between it and the obliterated part of the umbilical artery, or, still more medially, between the obliterated part of the umbilical artery and the lateral border of the rectus. Such herniæ, because they do not pass obliquely along the inguinal canal but more directly through its posterior wall, are called by the surgeon *direct inguinal herniæ*. As there are no congenital diverticula of the peritoneum in these regions such herniæ must be due either to the slow distension of weak points in the posterior wall of the inguinal canal, under the influence of the intra-abdominal pressure, or to the instant rupture of such points when the pressure is suddenly increased. After a pouch of the posterior wall, containing gut, has been protruded into the canal, or after a portion of the peritoneal sac containing gut has been forced through the posterior wall into the canal, the action of the abdominal pressure will tend to force the protrusion along the line of least resistance, which is usually along the canal to the subcutaneous inguinal ring. The coverings of the direct hernia will differ according to whether the hernia has torn the posterior wall or forced it forwards as a covering, and, in the latter case, according to whether the hernia has passed from the medial inguinal pouch, between the inferior epigastric artery and the obliterated part of the umbilical artery, or through the supravesical pouch, at the medial side of the obliterated artery. The coverings of the hernia passing from the medial inguinal pouch will be the same as those of the oblique hernia, except that transversalis fascia will take the place of internal spermatic fascia; but if the hernia passes from the supravesical pouch, on the medial side of the obliterated part of the umbilical artery, it will push before it the falx inguinalis, it will enter the canal below the upper border of the cremasteric fascia, and it will receive no sheath from the latter fascia; from within outwards, therefore, its anatomical coverings will be—(1) peritoneum, (2) extra-peritoneal fat, (3) transversalis fascia, (4) falx inguinalis, (5) external spermatic fascia, (6) superficial fascia, (7) skin. The student should understand also that whilst it is commonly believed that oblique herniæ are usually due to the persistence of a portion of the processus vaginalis, there is no anatomical reason why a new peritoneal sac should not be formed in the region of the lateral inguinal fossa, that is, in the region of the abdominal inguinal ring, as easily as in other regions. If such a pouch were formed it would pass along the line of the canal, its coverings would be similar to those of a hernia which had passed into the upper persisting part of the processus vaginalis, and its relationship to the tunica vaginalis would depend largely upon the size of the latter sac, that is, upon how much of the lower part of the original processus remained unobliterated, and upon the more anterior or more posterior position of the upper end of the tunica vaginalis.

Femoral Hernia.—This consists in the protrusion of some abdominal contents from the abdominal cavity into the region of the thigh. In its descent it passes *behind* the inguinal ligament, along the *femoral canal* of the femoral sheath. It is consequently mainly the duty of the student who is engaged in the dissection of the lower limb, and within whose domain the femoral sheath lies, to investigate the anatomical connections of this variety of hernia (Vol. I. p. 243). Still, it is essential that the dissector of the abdomen should examine,

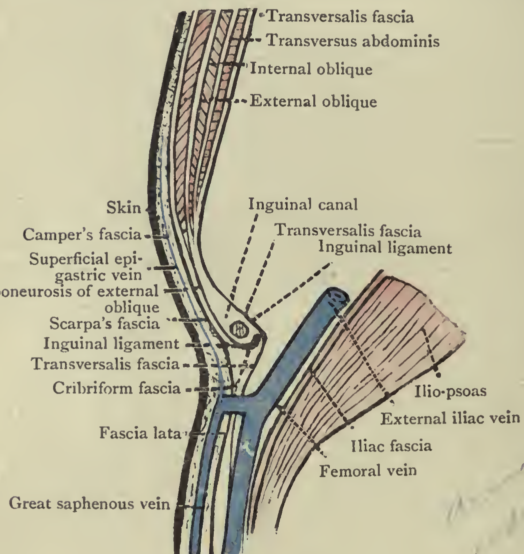


FIG. 116.—Diagram of a Sagittal Section through the lower part of the Anterior Wall of the Abdomen in the region of the Inguinal Canal.

from its abdominal aspect, the *femoral ring*, or aperture of communication between the femoral canal and the abdominal cavity, and give the dissector of the lower limb an opportunity of doing so likewise.

The *femoral ring* is placed immediately below the inguinal ligament, in the interval between the external iliac vein and the base of the lacunar ligament (Gimbernati) and therefore below the inguinal canal. If the peritoneum is still in position at that point it may exhibit a slight dimpling or depression as it passes over the ring. Strip the peritoneum from the greater part of the iliac fossa. The extra-peritoneal fatty tissue, as it stretches across the femoral ring, will be observed to be denser, stronger, and more fibrous than elsewhere. A special name is applied to that small portion of the extra-peritoneal fatty tissue. Seeing that it is applied to the ring in such a manner as to close the femoral canal at its abdominal end, it is called the *septum femorale.*

> ***Dissection.***—With the handle of the knife dissect away the extra-peritoneal fatty tissue in the area from which the peritoneum has been displaced. The *fascia iliaca* covering the iliacus and psoas muscles will then be exposed, and the dissector should note that the external iliac vessels lie *inside* and not *outside* that fascia.

The dissector is now in a position to study the manner in which the *femoral ring* is formed. He should follow the fascia iliaca and the fascia transversalis towards the inguinal ligament. If the dissection has been carefully performed it will be obvious that, to the lateral side of the external iliac vessels, these two fasciæ become directly continuous with each other, and, further, that along the line of union they are both firmly attached to the inguinal ligament. It is evident, then, that no hernial protrusion could leave the abdominal cavity behind the inguinal ligament lateral to the iliac vessels.

In the region of the iliac vessels the arrangement of the fascia will be found to be different. There the fascia iliaca is carried downwards behind the vessels, whilst the fascia transversalis is prolonged downwards in front of the vessels and behind the inguinal ligament (Fig. 116). In the region of the thigh the two fasciæ form a funnel-shaped sheath for the femoral artery and vein, and for some lymph vessels ascending to the abdomen. The sheath is divided into three compartments by two antero-posterior partitions. The femoral artery occupies the lateral compartment, and the vein the intermediate compartment, whilst the medial compartment, called the *femoral canal,* is occupied by the lymph vessels and, sometimes, by a small lymph gland.

An essential difference between the compartments is that whilst the lateral two are completely filled up by the artery and vein, the femoral canal is much wider than is necessary for the passage of its contents. Gauge the width of the femoral ring by introducing the point of the little finger. It is readily admitted within the opening. Here, then, is a source of weakness to the abdominal wall, and one which is greater in the female than in the male, seeing that the distance between the iliac spine and pubic tubercle is proportionally greater in the female, and, in consequence, the femoral ring wider.

When the finger is within the ring, mark the structures which surround it—*anteriorly*, the inguinal ligament, with the spermatic cord or the round ligament of the uterus; *posteriorly*, the ramus of the pubis, giving origin to the pectineus muscle, which is covered by the pectineal portion of the fascia lata; *medially*, the sharp, crescentic free border of the lacunar ligament; and *laterally*, the external iliac vein.

It is still more necessary to note the relations of the blood-vessels to the femoral ring. The *external iliac vein* has been seen to lie to its lateral side. The *inferior epigastric artery*, as it ascends on the posterior aspect of the abdominal wall, is close to the upper and lateral margin of the ring, and it sends its *pubic branch* medially in front of the ring. More important than any of those relations is the relation of the *obturator artery*, when it takes origin from the inferior epigastric. That anomalous vessel may adopt one of three courses:—(1) It may follow the course of the pubic artery, an enlarged form of which it in reality is, and pass medially *in front* of the ring, and then descend along its *medial* margin. In that case, the ring is surrounded on all sides, except posteriorly, by important vessels. (2) It may pass downwards and backwards across the femoral ring. (3) It may run downwards between the ring and the external iliac vein (*vide* Vol. I. p. 244).

Medial to the femoral sheath the passage of a hernial protrusion behind the inguinal ligament is effectually prevented by the lacunar ligament.

Femoral hernia is more common in females, and inguinal hernia in males; and for the very evident reason that, in the female, the femoral canal is relatively larger, whilst in the male the passage of the spermatic cord weakens the inguinal region more than the passage of the small round ligament of the uterus in the female.

Umbilical Hernia.—If the dissector examines the umbilicus he will find that he is dealing with a dense fibrous ring which is fused with the remains of the umbilical vein and the remains of the obliterated parts of the umbilical arteries and the urachus, the whole forming a dense nodule of fibrous tissue closely connected with the superjacent skin. The umbilicus marks the position where, during a large part of intra-uterine life, the peritoneal cavity was prolonged through the abdominal wall into the root of the umbilical cord, which attached the fœtus to the mother. For a considerable time a portion of the gut lies in the extra-abdominal sac in the root of the umbilical cord, but, before birth, it is withdrawn into the abdomen and the sac shrinks and disappears. If a remnant of the sac persists in the substance of the abdominal wall, after birth, the wall is weakened and a portion of the abdominal contents may be forced into the diverticulum, causing its distension and producing an umbilical hernia. The anatomical coverings from within outwards would be—(1) peritoneum, (2) aponeuroses of the abdominal wall equivalent to the stretched linea alba, (3) superficial fascia, (4) skin.

If the fœtal condition persists until birth a portion of the gut lies in the umbilical cord, separating the three vessels; and more than one case has occurred in which the bowel has been cut when the cord was divided after the birth of the child.

— Name arteries in the abdominal wall —

ABDOMINAL CAVITY.

When the dissector has completed his examination of the regions where hernia most commonly occurs he should proceed to study the abdominal cavity and its contents.

also page 249 lumbar muscl

Dissection.—The lower half of the abdominal wall has already been divided along the median plane; now carry an incision upwards, from the umbilicus to the xiphoid process of the sternum, immediately to the left of the median plane, and throw the two flaps thus formed upwards and laterally over the lower margins of the thorax. The abdomen will then be fully opened up and the examination of its contents may commence. As the flap on the right side is turned upwards a strong fibrous cord will be noticed extending from the umbilicus to the inferior surface of the liver. It is the *ligamentum teres* of the liver and is the remains of the umbilical vein of the foetus. As it ascends towards the liver, it recedes from the posterior surface of the anterior abdominal wall, taking with it a fold of peritoneum termed the falciform ligament of the liver.

Shape and Boundaries of the Abdominal Cavity.—The abdominal cavity is ovoid in shape, and its vertical diameter is the longest. *Superiorly*, it is roofed by the dome-shaped *diaphragm*, which presents a deep concavity towards the abdomen. *Inferiorly*, its floor is formed by the *pelvic diaphragm*, consisting of the levatores ani and the coccygei muscles. The floor also is concave towards the abdominal cavity. Neither the roof nor the floor is complete and unbroken. The diaphragm is perforated by certain structures which pass between the thorax and the abdomen. The continuity of the pelvic diaphragm is broken by the passage of certain structures between the pelvic division of the abdominal cavity and the perineum. The upper part of the abdominal cavity extends upwards for a considerable distance under the shelter of the lower ribs and their costal cartilages. The protection which is thus afforded to the viscera in that portion of the cavity is most complete laterally and posteriorly. Anteriorly, a wide Λ-shaped gap is left between the costal cartilages of the opposite sides as they ascend towards the sternum. The level to which the costal arches descend on each side varies greatly in different subjects, but, in the great majority of cases, a narrow belt of abdominal wall, from one to two inches wide, is left between the lower border of the chest wall and the highest point of the iliac crest. The only skeletal support of that part of the wall lies behind and is provided by the lumbar part of the vertebral column.

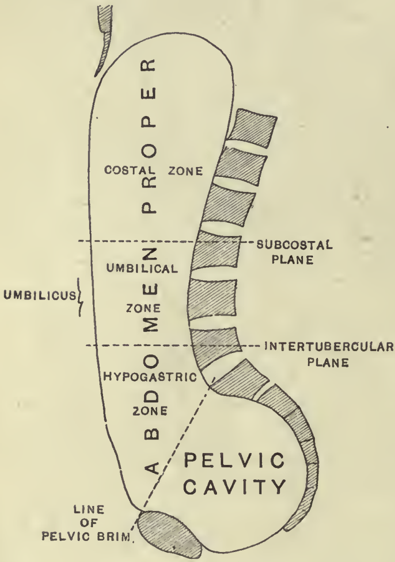


FIG. 117.—Outline of the Abdominal Cavity as seen in median section. The planes of subdivision are indicated by dotted lines.

At a lower level, the expanded iliac bones give support to the abdominal walls posteriorly and laterally, whilst, in the lowest part of the abdomen, the pubic, ischial, sacral, and coccygeal bones form very complete bony boundaries for the cavity.

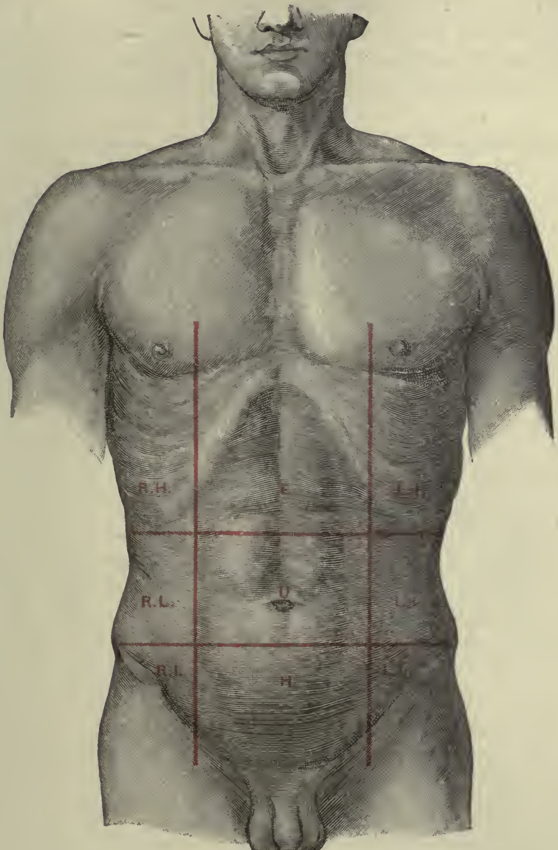


FIG. 118.—Planes of subdivision of the Abdominal Cavity.

R.H. Right hypochondrium.
R.L. Right lumbar region.
R.I. Right iliac region.
E. Epigastric region.
U. Umbilical region.
H. Hypogastric region.
L.H. Left hypochondrium.
L.L. Left lumbar region.
L.I. Left iliac region.

Whilst the abdominal cavity, therefore, is very fully protected, posteriorly and laterally, by skeletal parts, the anterior wall is almost entirely formed by the muscles and aponeuroses which have already been dissected.

It is obvious, however, that the roof, floor, and the greater part of the abdominal wall are composed of muscular structures, the contraction of which diminishes the capacity of the cavity and subjects the contained viscera to compression.

Subdivision of the Abdominal Cavity.—In order that the exact positions of the numerous and diverse contents of the abdomen may be accurately defined it is necessary to divide the cavity into regions. In the first place the cavity of the abdomen is divided into two principal parts, the *abdomen proper* and the *pelvis minor.* The plane of separation between the two is an imaginary plane which lies at the level of the upper aperture of the pelvis minor, extending from the front of the promontory of the sacrum to the upper border of the symphysis pubis. The two main parts of the cavity are not in direct line with one another. The long axis of the abdomen proper is nearly vertical; that of the pelvis minor is very oblique, and is directed backwards and downwards. The difference of direction is so great (see Fig. 117), and the difference in size is so marked, that the pelvis minor has the appearance of a large recess which projects backwards and downwards from the lower part of the abdomen proper.

The abdomen proper is still further subdivided by means of four arbitrary planes of section. Two of these pass through the body in a horizontal direction, and two in a vertical direction. The former are termed the *subcostal* and the *intertubercular planes* of subdivision, and the position of each is determined as follows:—A horizontal line, drawn around the body at the level of the most dependent parts of the tenth costal arches, indicates the position of the *subcostal plane.* A second line, drawn around the body at the level of the highest parts of the iliac crests, which can be seen from the front, gives the level of the *intertubercular plane.*

The highest part of each iliac crest which can be seen from the front lies about 50-60 mm. (two to two and a half inches) behind the anterior superior spine of the ilium. Its position is indicated by the junction of the lateral outline of the trunk with the outline of the hip bone at the point where a prominent tubercle juts out from the external lip of the iliac crest; hence the term intertubercular plane.

The two horizontal planes map out the abdomen into three districts or zones, which are termed, from above downwards—(1) the *costal*, (2) the *umbilical*, and (3) the *hypogastric zone*.

The two vertical planes of subdivision are called the *right* and *left lateral planes*. Each corresponds, on the surface, to a perpendicular line reared from the inguinal ligament at the

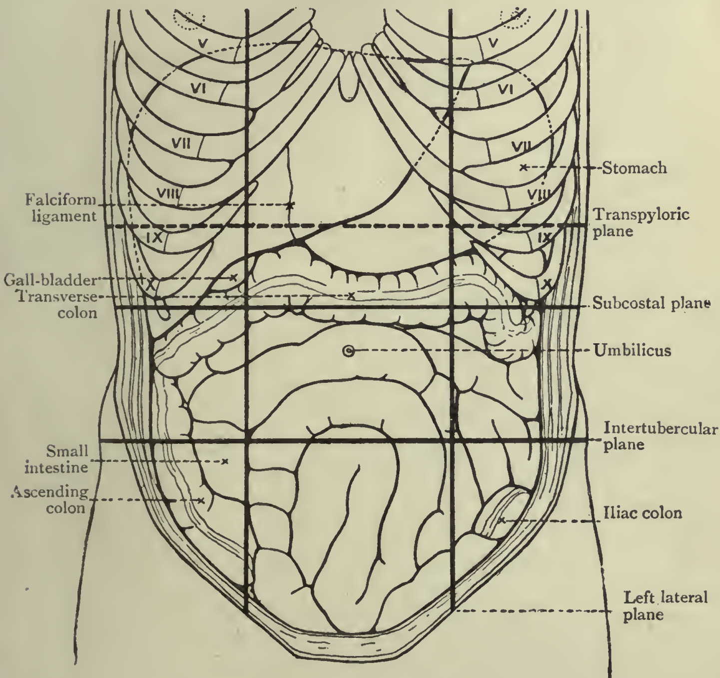


FIG. 119.—The Abdominal Viscera, as seen from the front, after removal of the greater omentum. The dark lines indicate the subdivision of the abdominal cavity. (Birmingham.)

midpoint between the symphysis pubis and the anterior superior spine of the ilium.

By the lateral planes, each of the three zones determined by the horizontal planes of section is subdivided into three parts.

The costal zone is mapped off into a central *epigastric region* and a *right* and a *left hypochondriac region*; the umbilical zone, into a central *umbilical region* and a *right* and a *left lumbar region*; and the hypogastric zone, into a central *hypogastric region* and a *right* and a *left iliac region.*

Contents of Abdomen Proper.—The following structures lie within the upper section of the abdominal cavity.

1. Abdominal part of the alimentary canal. — Stomach. Small intestine. Large intestine.
2. Glands situated outside the walls of the alimentary canal and pouring their secretions into it. — Liver, with its gall-bladder or reservoir. Pancreas.
3. The spleen.
4. The two kidneys, the ureters, and the two suprarenal glands.
5. Lymph glands, lymph vessels, the cisterna chyli, and the commencement of the thoracic duct.
6. The abdominal aorta, with its various visceral and parietal branches.
7. The inferior vena cava and its tributaries, and the commencements of the vena azygos and vena hemiazygos.
8. The vena portæ and its tributaries.
9. The lumbar plexuses of nerves.
10. The abdominal portions of the sympathetic nervous system.
11. The peritoneal membrane, which lines the cavity and invests the viscera.

When the abdominal cavity is opened, a very partial view of the contained viscera is obtained, so long as they are left undisturbed. On the right side of the costal zone the sharp margin of the liver may be observed, projecting slightly below the ribs, whilst, opposite the ninth costal cartilage, the fundus of the gall-bladder is seen, peeping out from under cover of the liver, and projecting slightly beyond its anterior border. In the same zone, to the left of the liver, a portion of the stomach is visible, and extending downwards from the greater curvature or anterior border of the stomach is a broad apron-like fold of peritoneal membrane, called the *greater omentum.* The greater omentum usually contains a quantity of fat in its meshes, and is spread out like an apron, so as to hide from view the viscera which occupy the lower two zones. Sometimes, however, the greater omentum is narrow and short; or it may be turned more or less completely upwards or to one side. In either case some of the coils of the small intestine will be seen, and also, in all probability, those parts of the large intestine which occupy the right and left iliac fossæ. The part lying in the right iliac fossa is called the *cæcum,* whilst the part situated in the left iliac fossa is the *iliac colon.* It may also chance that the urinary bladder is full, in which

PLATE VII

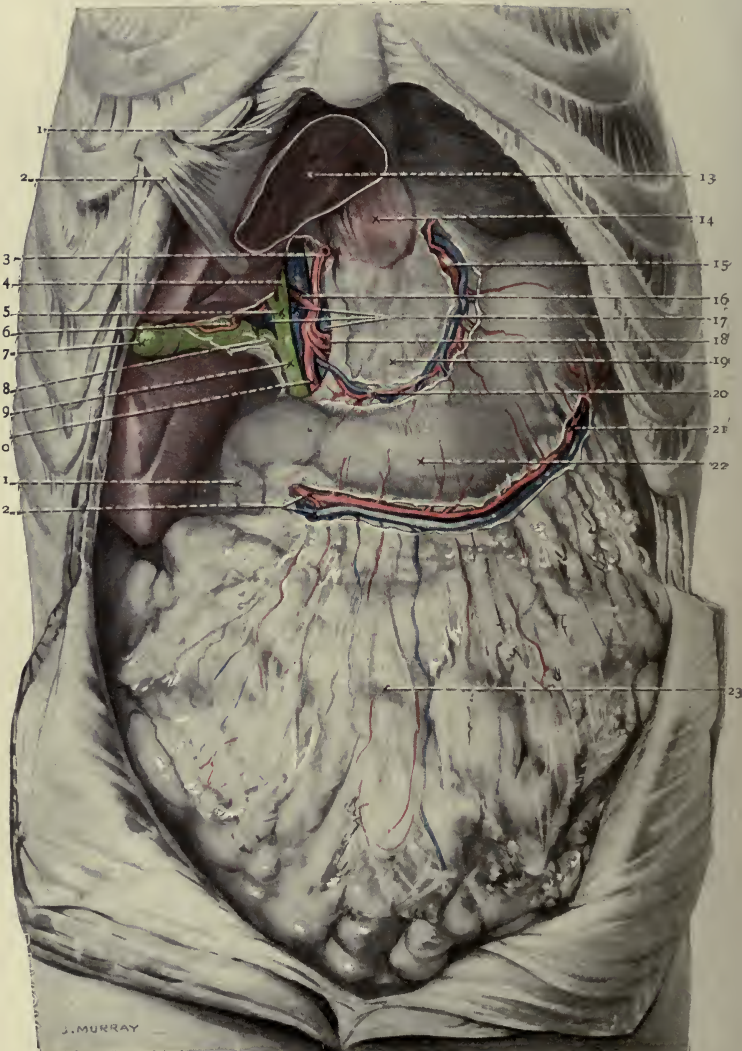


FIG. 120.

PLATE VII

FIG. 120.—View of the Interior of the Abdomen.

The upper part of the anterior wall of the abdomen has been removed. The lower part has been divided in the median plane and turned aside.

The greater part of the left lobe of the liver has been removed and the pyloric part of the stomach has been displaced downwards.

The liver is seen in the upper and right portion of the abdominal cavity, with the gall-bladder and the cystic artery on the inferior surface of its right lobe.

The round ligament of the liver and the falciform ligament have been pulled over the right costal arch and have been fixed to the wall of the thorax. From the point of attachment the round ligament runs downwards and backwards to the umbilical fossa of the liver, and the falciform ligament extends backwards to the anterior and upper surfaces of the liver.

Below and to the left of the liver is the stomach, which is connected to the liver by a fold of peritoneum called the lesser omentum. From the lower border of the stomach the greater omentum hangs down in front of the contents of the lower part of the abdominal cavity.

The anterior layer of the lesser omentum has been removed along the upper or lesser curvature of the stomach, to display the right and left gastric vessels, which lie between the two layers; and it has been removed also along the right or free margin of the omentum, to display the hepatic artery and its branches, the portal vein and the bile duct, the cystic duct and the common hepatic duct.

By the displacement downwards of the pyloric end of the stomach, the gastro-duodenal branch of the hepatic artery has been brought into view.

The anterior layer of the greater omentum has been removed along the lower part of the greater curvature of the stomach to display the right and the left gastro-epiploic vessels.

1. Falciform ligament.
2. Ligamentum teres.
3. Left hepatic artery.
4. Left hepatic duct.
5. Common hepatic duct.
6. Cystic artery.
7. Fundus of gall-bladder.
8. Cystic duct.
9. Bile duct.
10. Gastro-duodenal artery.
11. Duodenum, descending part.
12. Right gastro-epiploic vessels.
13. Face of section of left lobe of liver.
14. Caudate lobe, seen through lesser omentum.
15. Left gastric artery.
16. Right hepatic artery.
17. Portal vein.
18. Hepatic artery.
19. Lesser omentum.
20. Right gastric vessels.
21. Left gastro-epiploic artery.
22. Stomach.
23. Greater omentum.

case its apex will be observed projecting above the pubes. Lastly, in pregnant females the gravid uterus will be visible, reaching a height which varies with the period of gestation.

Raise the greater omentum and turn it upwards over the inferior margin of the thorax. By that proceeding the coils of the small intestine will be exposed, and a part of the large intestine, the *transverse colon*, which extends across the cavity of the abdomen will also be brought into view. It is attached to the posterior part of the greater omentum.

Note that all the viscera which have been seen are covered by a smooth glistening membrane, *the peritoneum*. That membrane forms the immediate boundary of a space, *the peritoneal cavity*, which has been opened into by the reflection of the anterior wall of the abdomen. The dissector should recognise that under normal circumstances the peritoneal cavity is merely a potential cavity, and that it becomes an actual cavity only when the surgeon or dissector pulls its walls apart when opening into it, or when its walls are forced apart by abnormal collections of fluid or gas.

Replace the greater omentum and commence a fuller consideration of the general position, relations, and connections of the viscera by examining the general position of the liver.

Hepar.—The liver is the large, reddish-brown organ which occupies a large part of the upper portion of the abdomen, where it lies in the epigastric region and both hypochondriac regions. A very large portion of its surface is in contact with the diaphragm, which separates it from the contents of the lower part of the thorax. The inferior border of its anterior surface crosses the subcostal angle from above downwards and to the right, and continues to the right, either along or immediately below the right costal arch. Opposite the tip of the ninth right costal cartilage the fundus of the gall-bladder projects from beneath it. Pass the hand over the anterior and upper surfaces of the liver, and note that they are connected to the anterior abdominal wall and to the diaphragm, respectively, by a fold of the peritoneal lining of the abdomen which is called the falciform ligament. Raise the inferior margin of the liver and note that the lower and posterior surfaces of the liver are connected to the stomach by a fold of peritoneum called the *lesser omentum*. A more detailed account of the attachments of the liver is given on p. 365.

Dissection.—**Fasten the lower border of the anterior surface of the liver to the right costal arch and examine the stomach.**

Ventriculus.—The stomach is a pear-shaped organ which lies in the left hypochondriac and epigastric regions, partly below and partly to the left side of the liver. Its long axis runs obliquely and is curved upon itself, the base or *fundus* of the organ being situated above, behind, and to the left, whilst the apex or *pylorus* lies lower, more anteriorly,

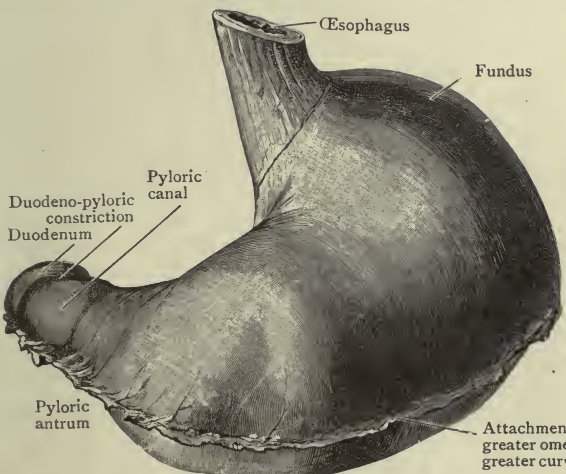


FIG. 121.—Stomach of a Child, two years of age, hardened *in situ* by formalin injection.

and more to the right. Traced from its highest to its lowest point, it runs first forwards and slightly downwards, then to the right, and finally slightly backwards to its junction with the duodenum or proximal portion of the small intestine. When the left lobe of the liver is pulled upwards and to the right the œsophagus will be found entering the stomach, a little to the right of the highest point of the fundus, at the *cardiac* or *œsophageal orifice.* From that point the two borders of the stomach can be traced to the pyloric end of the organ. The upper border or *lesser curvature* is much the shorter; it runs downwards and to the right in a fairly uniform curve. The *greater curvature* is much longer. First it ascends from the œsophagus to the highest point of the fundus. After crossing the fundus it runs forwards and downwards with a marked convexity to the left; finally it runs to the right and slightly backwards with a convexity downwards. The second portion is frequently spoken of as the left lateral border and the last portion as the inferior border of the stomach; the junction of these two parts is commonly the lowest portion of the organ and, when the body is recumbent, it lies on a level with the tips of the tenth costal cartilages, but in the erect posture, and when the stomach is full it may descend to a much lower point, even to the level of the umbilicus or still lower. The dissector will find that the lesser curvature is attached to the lower and posterior surfaces of the liver by a fold of peritoneum which is called the *lesser omentum.* The part of the greater curvature immediately adjacent to the œsophagus is attached to the diaphragm by a peritoneal fold, the *gastro-phrenic ligament*; the descending part of the greater curvature is attached to the spleen by the *gastro-splenic ligament* (O.T. *gastro-splenic omentum*); and the lower part of the greater curvature is connected with the transverse colon by the *greater omentum.* The first of these connections can be demonstrated by pulling the stomach downwards, the second, by pulling it to the right, and the last, by raising the greater omentum, which hangs down from the lower border, and turning it upwards over the lower margin of the costal arch. The surfaces of the stomach are an anterior or superior and a posterior or inferior. The latter cannot be seen at the present stage of dissection; it rests on the stomach bed. The anterior is directed upwards and forwards; and the student should note that it is in relation to the left and above with the diaphragm, below with the anterior wall of the abdomen, in the region of the subcostal angle, and above and to the right with the lower surface of the liver.

The above account gives an indication of the general form, position, and relations of the stomach which are met with after death when the body is lying upon its back, but the student must realise that whilst the connections of the stomach are always the same, its size, form, and position vary with the amount of its contents, the stage of digestion, and the position of the body. A glance at Figs. 122, 123, 124, 125, which represent drawings of radiographs of stomachs in different conditions of distension, digestion, and position of the body,

PLATE VIII

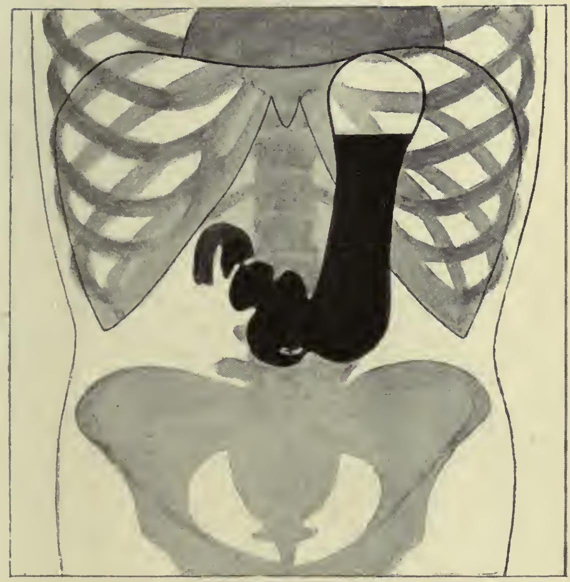


FIG. 122.

Drawing from radiograph of normal stomach as seen in the vertical position after an ordinary bismuth and barium meal containing two ounces of bismuth and two ounces of barium sulphate. It shows the depressions caused by peristaltic contractions towards the pylorus, and as these are constantly moving towards the pylorus they are not due to fixed anatomical constrictions, and are therefore omitted from the other plates. The pylorus and commencement of the duodenum are shown.

As the drawing was made orthodiagraphically, it is therefore to scale and not distorted. Drawing by A. F. Hertz, M.D., F.R.C.P.

PLATE IX

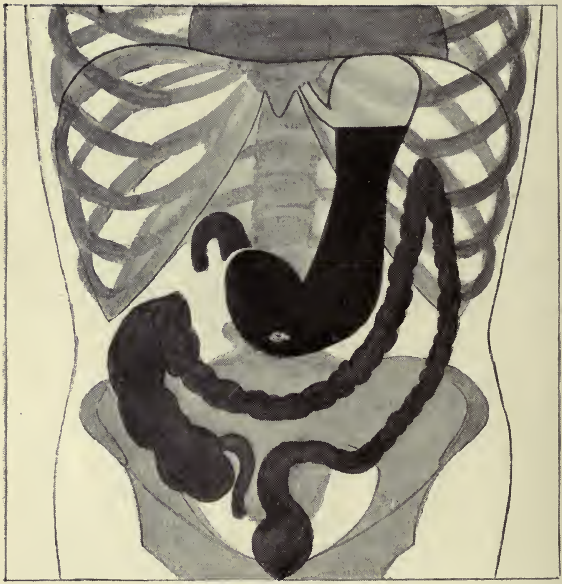


FIG. 123.

Drawing of radiograph of a normal stomach in the vertical position after an ordinary bismuth meal without the contractions seen in the preceding plate.

The lighter shadow is a composite drawing taken at varying periods after the meal, showing the appearance of the lowest part of the ileum, the cæcum, and large intestine as the bismuth was passing through.

The tracings were made orthodiagraphically, and are therefore to scale and not distorted. Drawing by A. F. Hertz, M.D., F.R.C.P.

PLATE X

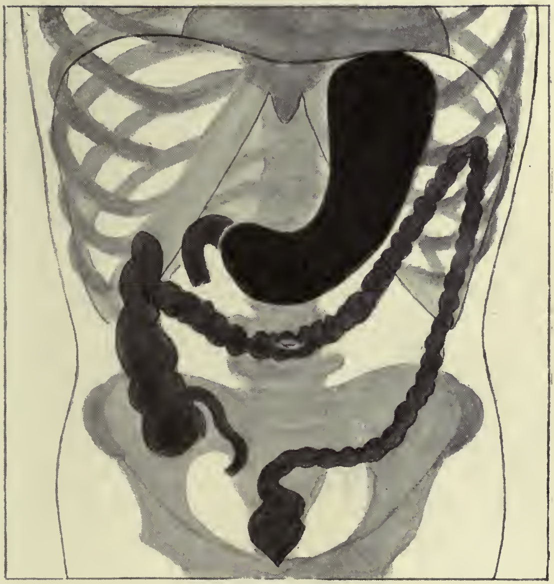


FIG. 124.

Drawing from tracing of radiograph of a normal stomach taken in the *horizontal position* immediately after an ordinary bismuth and barium meal.

The lighter shadow is a composite tracing of the ileum and large intestine taken as in Plate IX.

The tracings were made orthodiagraphically, and are therefore to scale and not distorted. Drawing by A. F. Hertz, M.D., F.R.C.P.

PLATE XI

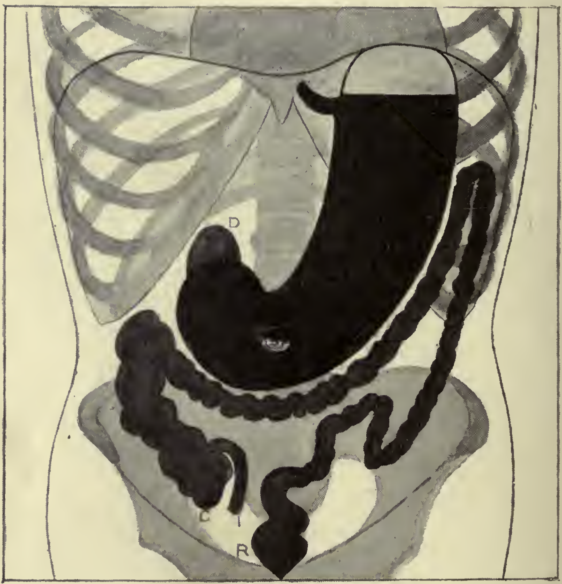


FIG. 125.

Drawing of a normal stomach as seen with X-Rays in the vertical position after an ordinary dinner with two ounces of barium sulphate added. D = the duodenum, and the light mark indicates the position of the umbilicus.

As in the previous plates the lighter shadow represents a composite tracing of the ileum (I), cæcum (C), large intestine, and rectum (R), taken at varying periods after. Note the additional loop at the commencement of the pelvic colon, often seen in normal individuals.

The drawings were made orthodiagraphically, and are therefore to scale and not distorted. Drawing by A. F. Hertz, M.D., F.R.C.P.

shows, at once, that whilst the position of the fundus remains constant, and that of the pylorus is relatively constant, the other parts of the organ vary considerably in size and position, and that the lowest part of the organ instead of remaining in the costal zone of the abdominal cavity frequently descends into the umbilical region, whilst Fig. 126 shows that the form of the stomach met with in dissecting-room subjects is also very variable. After examining the stomach the dissector should look for the spleen.

Lien (The Spleen).—If the spleen is of normal size and is

FIG. 126.—Anterior views of six Stomachs removed from dissecting-room subjects. A, Œsophagus; B, Pylorus.

lying in its normal position, it cannot be seen, when the abdominal organs are undisturbed, but it can easily be felt if the hand is passed backwards, round the left margin of the stomach, into the posterior part of the left hypochondriac region, and it can be brought into view by pulling the stomach towards the right side. When that has been done the spleen will be found to be attached to the stomach by a fold of peritoneum called the *gastro-splenic ligament* (omentum) and it is attached to the anterior surface of the left kidney, which can easily be felt, behind the spleen, by a fold of peritoneum called the *lieno-renal ligament*. The dissector should note that the lower end of the spleen is supported by an angular bend of the large intestine, called the *left colic flexure*, and by a fold of peritoneum, the *phrenico-colic ligament*, which connects the left colic flexure with the lower surface of the diaphragm, at the level of the eleventh rib in the mid-axillary line.

Intestinum (The Intestine). — When the dissector has satisfied himself regarding the general position and attachments of the liver, stomach, and spleen, he should familiarise himself with the parts, position, and the attachments of the intestine. There are two main parts of the intestine, the

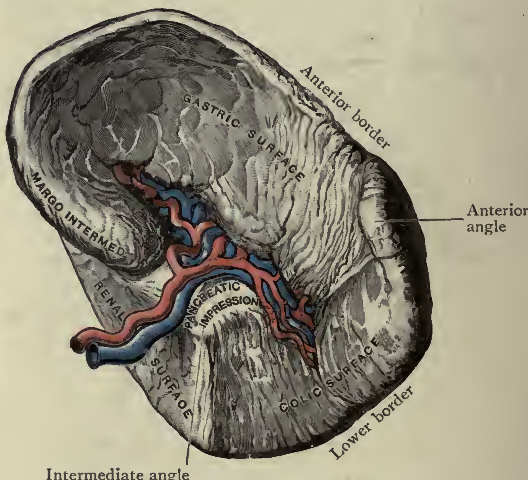


FIG. 127.—The Spleen (visceral aspect).

small and the large. They cannot, however, be distinguished from each other by size alone, for the calibre of each part varies according to the state of contraction or relaxation of its muscular walls.

The small intestine commences at the pyloric end of the stomach, under cover of the liver, which must be raised to expose it. The termination of the stomach and the commencement of the intestine are marked by a thick ring of muscle fibres, the *sphincter pylori*, and in many cases by a distinct constriction due to the contraction of the sphincter. The first part of the intestine, the *duodenum*, runs backwards from the pylorus to the upper part or *neck* of the gall-bladder; there it turns downwards and disappears from view behind a portion of the large intestine called the transverse colon. To trace it further, turn the greater omentum upwards over the lower part of the thoracic wall and expose the area below and behind the omentum. The central and greater portion of that area is filled with coils

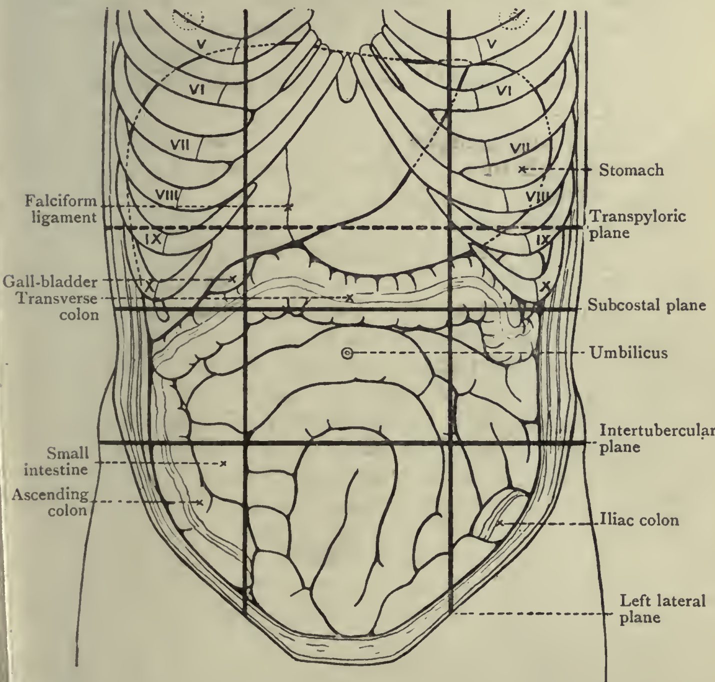


FIG. 128.—The Abdominal Viscera, as seen from the front, after removal of the greater omentum. The dark lines indicate the subdivision of the abdominal cavity. (Birmingham.)

of the small intestine, but at the lateral and upper borders of the area portions of the large intestine are seen.

A mere glance is sufficient to distinguish the small from the large intestine. The chief points of difference are—(1) The wall of the small intestine is smooth and uniform, whereas the wall of the large intestine is puckered and sacculated. (2) The longitudinal muscle fibres in the wall of the small intestine are distributed uniformly round the tube, but in the large intestine they are collected into three longitudinal bands, called *tæniæ coli*, which are separated from each other by intervals and are distinctly visible to the naked eye. The bands are shorter than the tube itself; consequently the walls of the tube are puckered. (3) Attached to the great intestine are the *appendices epiploicæ*. They are small peritoneal pouches, containing fat, which hang from the free border of the gut.

The dissector should attempt to pull the small intestine forwards, and he will find that it is attached to the posterior wall of the abdomen by a fold of peritoneum, called *the mesentery*, which runs obliquely downwards and to the right, from the level of the left side of the second lumbar vertebra to the right iliac fossa.

The parts of the large intestine lying to the right of the mass of coils of small intestine are the cæcum below and the ascending colon above. The part crossing from side to side is the transverse colon; it is above the small intestine, now that the greater omentum is reversed, but it is normally in front of the small intestine; it is attached to the posterior wall of the abdomen by a fold of peritoneum called the *transverse meso-colon*. The parts to the left of the coils of the small intestine are, from above downwards, the descending colon in the lumbar region, and the iliac colon in the left iliac region.

The portion of the small intestine which is attached to the posterior wall of the abdomen by the mesentery is arbitrarily divided into two parts, an upper two-fifths, called *jejunum* (*intestinum jejunum*), and a lower three-fifths, called *ileum* (*intestinum ileum*). Pull the jejunum and ileum downwards and to the left and follow the mesentery to its highest point, there the jejunum will be found to become continuous with the terminal part of the duodenum at a distinct flexure, the *duodeno-jejunal flexure*, which is not enclosed in the mesentery but lies behind the peritoneum below the arch of the transverse meso-colon. If the dissector will now hold the omentum forwards he will be able to trace the first or superior part of the duodenum from the pyloric end of the stomach, backwards to the neck of the gall-bladder, the second or descending part downwards behind the transverse colon, on the right of the median plane, and finally the third or inferior part from right to left, behind the upper part of the mesentery, to the duodeno-jejunal flexure, where it becomes continuous with the jejunum. He will thus demonstrate the continuity of the three portions of the duodenum.

Next he should follow the mesentery downwards into the right iliac fossa, where he will find that the terminal portion of the ileum joins the large intestine a short distance above the lower end of the latter and on its left side. The portion of the large intestine below the entrance of the ileum is a sac which terminates blindly below and is called the *cæcum* (*intestinum cæcum*). Turn the cæcum and the lowest part of the ileum upwards and to the right to expose the *vermiform process*, which springs from the medial and posterior aspect of the cæcum a short distance below the ileo-cæcal junction. The cæcum is continuous above with the *ascending colon*, which must be traced upwards to the right hypochondriac region where, under cover of the anterior part of the lower surface of the liver, it joins the transverse colon at an angular bend, called the *right flexure of the colon* (O.T. *hepatic flexure*). The *transverse colon* extends across the abdomen from the right to the left hypochondriac region, forming a bold curve with the convexity directed downwards and forwards. It is connected to the stomach by the greater omentum and to the posterior wall of the abdomen by the transverse meso-colon. It is exposed when the omentum is turned upwards over the lower part of the costal arch and it will be found to terminate, immediately below the inferior extremity of the spleen, by joining the *descending colon* at a second angular bend, called the *left flexure of the colon* (O.T. *splenic flexure*). The descending colon passes downwards through the left lumbar region, and, at the level of the iliac crest, it becomes the *iliac colon*, which runs downwards and medially across the left iliac region, parallel with the inguinal ligament, to the brim of the pelvis minor, where it becomes the *pelvic colon*. To expose the pelvic colon lift the coils of small intestine out of the pelvis minor. It will then be found either that the pelvic colon runs first across to the right side of the pelvis, above the bladder, then back to the left side, and finally downwards and medially to the third piece of the sacrum, where it becomes continuous with the *rectum*; or that the first loop, instead of lying on the upper surface of the bladder, hangs down into the pelvis close to its left side. The *rectum* commences at the termination of the pelvic colon and runs downwards and forwards to end in the anal canal. Only its upper part can be seen at present, the lower part being concealed by the bladder, and in the female by the vagina (see Figs. 85, 224).

It is extremely important that the surgeon, who is operating in the abdomen, shall be able to tell at once whether he is handling a coil of small or of large intestine. The dissector should note that the size of the coil cannot be depended upon to decide the question, for the size depends to a large extent on the state of contraction or distension of the wall of the gut. Position is a better guide, but it also is not entirely reliable, for portions of the large intestine are very liable to be displaced from their usual positions. There are, however, certain external characteristics of the two main parts of the intestine which can always be relied upon to furnish the necessary evidence. (1) The walls of the large intestine are sacculated; (2) The longitudinal muscle fibres of the wall of the large intestine form three definite bands, two of which can usually be distinguished through the peritoneum, one along the free border of the gut, that is the border opposite the mesenteric attachment, or furthest away from the posterior wall of the abdomen, and another which lies along the medial border, in the cases of the ascending, descending, iliac, and pelvic portions of the colon, and along the inferior border of the transverse colon; (3) The third and, at the same time, the most easily recognisable and most distinctive feature of the large intestine is the presence of little fat-laden pouches of peritoneum called *appendices epiploicæ*, which are attached to the free border of the gut. None of the three features mentioned in connection with the large intestine are present in the case of the small intestine; on the contrary, its walls are not sacculated; it possesses no specialised longitudinal muscular bands, and it has no appendices epiploicæ attached to its walls.

If the subject is a female the **uterus** will be found occupying the central part of the pelvis. It lies between the rectum behind, and the bladder in front, and is connected on each side to the side wall of the pelvis by a fold of peritoneum called the *broad ligament* (see Figs. 224, 225, 228).

The dissector should notice that the cæcum presents the appearance of a blind diverticulum clothed on all sides with peritoneum; that the transverse colon and the pelvic colon are attached to the posterior wall of the abdomen by folds of peritoneum called mesenteries; that the vermiform process is attached to the posterior surface of the mesentery of the ileum by a fold of peritoneum called the *mesentery of the vermiform process* (O.T. meso-appendix); and that the remaining parts of the large intestine are not, as a rule, provided with mesenteries, but that they lie against the posterior wall of the abdomen, projecting forwards against the peritoneum, which covers them only anteriorly and on the sides. He should also note that portions of both the large and the small intestine lie in the pelvis minor. The parts of the small intestine in that situation are usually the lower coils of the ileum, and the parts of the large intestine are the pelvic colon and the rectum.

After the dissector has familiarised himself with the positions, continuity, and attachments of the various parts of the abdominal portion of the alimentary canal he should proceed to locate the kidneys. Throw the omentum upwards, pull the small intestine downwards and to the right, and examine the concavity of the left flexure of the colon, where a considerable part of the lower portion of the left kidney can be *seen and felt*, as it lies behind the peritoneum. Pull the small intestine over to the left and downwards, examine the concavity of the right flexure of the colon, and note that only a small part of the lower portion of the right kidney can be felt and seen in that situation, behind the peritoneum. Replace the small intestine and the omentum, pull the liver upwards and to the right, and the greater part of the upper portion of the right kidney will be exposed or can be felt in the region immediately above the right flexure of the colon. Replace the liver and pass the hand backwards into the posterior part of the left hypochondrium, to the back of the spleen, and palpate the upper and lateral part of the left kidney, as it lies against the diaphragm.

The positions and connections of the various viscera must now be studied in greater detail. Commence with the consideration of the liver.

Hepar (The Liver).—The liver has already been seen in the subcostal angle and projecting below the right costal margin. It is the largest gland in the body, and is a solid pliant organ, which occupies a large part of the epigastric and right hypochondriac regions, and smaller portions of the left hypochondriac and right lumbar regions. It is almost entirely surrounded by the peritoneal lining of the abdomen. The portions which can be investigated, at the present stage of dissection, are smooth to the touch, and they present a smooth and glistening appearance. The dissector should pass his hand over the surfaces of the organ

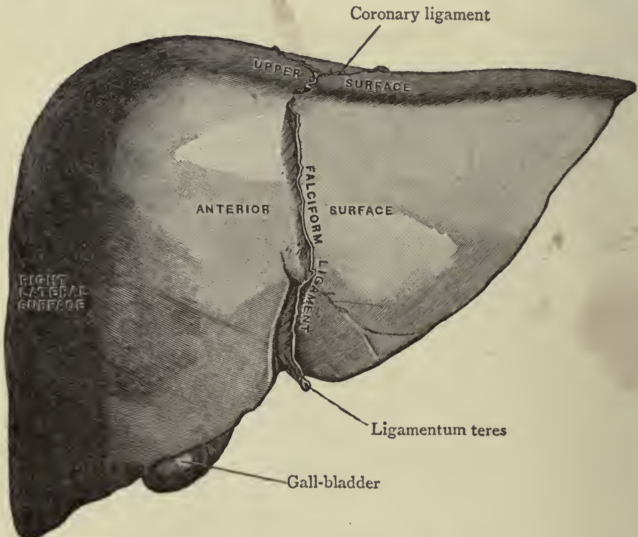


FIG. 129.—Anterior Surface of the Liver.

and he will find that it has the form of an irregular four-sided pyramid. The *base* of the pyramid lies to the right, where it is in contact with the diaphragm, from the level of the seventh to the level of the eleventh rib in the mid-axillary line. The edge-like *apex* lies to the left, at the level of the left sixth rib in or near the left lateral plane. The *anterior* and *superior* surfaces are smooth and convex. The anterior is attached to the anterior abdominal wall, and the superior to the under surface of the diaphragm, by a fold of peritoneum, called the falciform ligament, which separates each surface into a smaller left and a larger right portion, corresponding to the left and right lobes of the liver respectively.

The anterior surface is triangular in outline. It passes gradually, over rounded and indistinct borders, into the superior surface and the base, but it is separated from the inferior surface by a sharp and definite margin. Its left and right portions are in contact with the diaphragm, and the intermediate part is in contact with the anterior wall of the abdomen in the region of the subcostal angle. Its position can be indicated on the surface by three lines. (1) The first commences at the level of the left sixth rib in the left lateral plane, ascends to the fifth intercostal space in the right lateral plane, then descends in a steep curve to the seventh rib in the mid-axillary line. (2) The second commences at the same point as the first and passes obliquely downwards and to the right across the tip of the tenth right costal cartilage to the eleventh rib in the mid-axillary line. (3) The third connects the right extremities of the first and second.

The *superior surface* is accurately adapted to the lower surface of the diaphragm, which separates it from the lungs and pleuræ, and from the heart and pericardium. Immediately below the heart it is slightly concave, but to the right and left of the cardiac concavity it is markedly convex, and more convex on the right than on the left side. Pass the hand backwards over the upper surface of the right lobe and note that in the right lateral plane it rises to the level of the fourth intercostal space, or even to the lower border of the fourth rib.

Pass the hand still further back over the upper surface, and note that at the junction of the superior and posterior surfaces a layer of peritoneum, the upper layer of the *coronary ligament*, passes from the liver to the diaphragm. Carry the fingers to the right along the coronary ligament round to the base where, at the junction of the base with the posterior surface, a triangular fold of peritoneum, the *right triangular ligament*, will be found, connecting the liver with the diaphragm. Now pass the hand over the upper surface of the left lobe, and note that before the posterior border is reached the fingers are carried up to the diaphragm by a triangular fold of peritoneum, the *left triangular ligament* (see Fig. 172).

Examine the lower border of the anterior surface; note that it is cleft at the lower margin of the attachment of the falciform ligament by a notch called the *umbilical notch.* Through that notch, between the right and left lobes, the ligamentum teres, which lies in the rounded lower margin of the falciform ligament, passes into the umbilical fossa on the lower surface of the liver. Further to the right, in or near the right lateral plane and opposite the tip of the ninth right costal cartilage, the fundus of the gall-bladder projects below the liver, in the majority of cases.

Raise the lower margin of the liver and examine the *inferior surface.* It looks downwards, backwards, and to the left, and, over the whole of its extent, it is in contact with other viscera; on that account it is frequently called the *visceral surface.* It conceals the upper and right portion of the anterior surface of the stomach, the first part and the upper portion of the second part of the duodenum, the lesser omentum, and the greater part of the gall-bladder; to the right of the gall-bladder it is in relation, posteriorly, with a large portion of the anterior surface of the right kidney, and, more anteriorly, with the right flexure of the colon (see Fig. 171). It is divided into right and left portions by a fossa, the *umbilical fossa*, which contains the ligamentum teres. The umbilical fossa extends from the umbilical notch in the lower border of the anterior surface to the junction of the inferior and posterior surfaces, where it becomes continuous with the *fossa for the ductus venosus.* Trace the lesser omentum upwards to the lower surface of the liver, and note that it is attached to the margins of a fissure, called the *porta hepatis*, which extends from the neck or uppermost part of the gall-bladder on the right to the umbilical fossa on the left. The *porta hepatis* lies immediately in front of the junction of the inferior with the posterior surface of the liver. Note, further, that the upper border of the lesser omentum is continued upwards on the posterior surface of the liver, where it is attached to the bottom of the fossa for the ductus venosus.

The posterior surface, which is largely in relation with the diaphragm, cannot be conveniently examined at present (see Fig. 172).

Vesica Fellea.—The gall-bladder is a small piriform sac, with a capacity of from 28.5 to 57 cc. (one to two ounces). Pull the liver upwards and to the right, and examine the position, attachments, and connections of the gall-bladder. It lies partly in the right hypochondriac region and partly in the epigastric region. Its lower extremity or fundus projects below the lower margin of the anterior surface of the liver, at the level of the ninth right costal cartilage, in the right lateral plane, immediately to the right of the lateral border of the right rectus abdominis muscle. From that point the body of the organ runs upwards, backwards, and to the left, to the right extremity of the porta hepatis, where its constricted upper end, called the *neck*, becomes continuous with the *cystic duct*, which connects the gall-bladder with the bile duct. The upper and anterior surface of the body of the gall-bladder is embedded in a sulcus on the inferior surface of the right lobe of the liver, which is called the *fossa for the gall-bladder*; and it is attached to the liver by areolar tissue and by a number of small veins which pass from the gall-bladder into the substance of the liver, where they communicate with branches of the portal vein. The fundus and the lower or posterior surface are covered with peritoneum, and the lower surface is in contact, posteriorly and above, with the first and second parts of the duodenum, and below with the transverse colon.

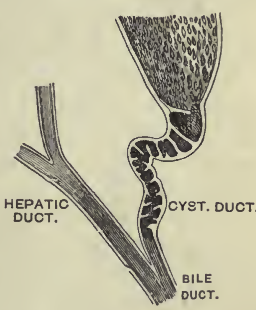


FIG. 130. — Diagram of the Cystic and Hepatic Ducts. (From Gegenbaur, modified.)

The cystic duct is enclosed in the right extremity of the upper border of the lesser omentum.

Dissection.—Make a longitudinal incision through the lower surface of the gall-bladder from the fundus to the neck, and examine the structure of its walls and its lining membrane. In addition to its partial serous covering it has (1) a strong coat composed of muscular and white fibrous tissue, and (2) an internal mucous coat. The mucous membrane is stained green by the bile, and it presents a honeycombed appearance, being raised into numerous ridges which surround polygonal depressions; in the neck of the gall-bladder the ridges assume a spiral form and constitute the so-called *spiral valve* of Heister, which is continued into the cystic duct.

To obtain a satisfactory view of the lesser omentum and its contents the left lobe of the liver must be removed. Cut through it from before backwards, immediately to the left of the line of attachment of the falciform ligament. On the lower surface the knife must be carried backwards along the umbilical fossa, close to its left margin, and it must emerge on the posterior surface in the fossa for the ductus venosus and close to the left margin of that fossa (see Fig. 131).

The portion of liver removed must be carefully preserved so that it may afterwards be re-attached to the right lobe.

Omentum Minus.—The lesser omentum is a fold of peritoneum which connects the lesser curvature of the stomach and the first part of the duodenum with the margins of the porta hepatis (O.T. transverse fissure) on the inferior surface of the liver, and with the bottom of the fossa for the ductus venosus on the posterior surface. Its left and lower margin is attached to the stomach and duodenum; its upper margin is attached to the liver; its right border is free and forms the anterior boundary of an aperture, called the *foramen epiploicum* (O.T. foramen of Winslow), which connects the cavity of the larger part of the peritoneal sac, called the *great sac*, with the smaller part, which is termed the *omental bursa.* The guide to the epiploic foramen is the gall-bladder. If the dissector passes his index finger upwards and backwards along the lower surface of the gall-bladder to its neck, and then turns it backwards and to the left, he will find that it passes through the epiploic foramen into the omental bursa.

The lesser omentum contains a large number of important structures between its two layers, viz.—two of the arteries which supply the stomach; the hepatic artery and the portal vein, which carry blood to the liver; the bile ducts, through which the bile is conducted to the duodenum; and numerous nerves, lymph vessels, and lymph glands. The dissector should now display the structures in the lesser omentum by removing portions of the anterior layer of the fold. It is not probable that he will be able to remove it in a continuous sheet; but he must take care not to destroy the posterior layer.

Dissection.—Commence at the upper border of the stomach, immediately below the œsophagus. Cut through the anterior layer of the lesser omentum and expose the *left gastric artery*; follow the artery downwards to its anastomosis with the *right gastric branch* of the hepatic artery, and upwards to the point at which it gives off its œsophageal branch; trace the latter along the œsophagus to the diaphragm. Remove the peritoneum from the front of the œsophagus and find the *left vagus nerve*, which descends on the front of the lower end of the œsophagus. Trace the terminal branches of the nerve to the wall of the stomach and into the lesser omentum. Whilst cleaning the left gastric artery the dissector may possibly see some of the *anterior left gastric lymph glands* at the upper extremity of the lesser curvature. Trace the right gastric

PLATE XII

FIG. 131.—View of the Interior of the Abdomen.

The upper part of the anterior wall of the abdomen has been removed. The lower part has been divided in the median plane and turned aside.

The greater part of the left lobe of the liver has been removed and the pyloric part of the stomach has been displaced downwards.

The liver is seen in the upper and right portion of the abdominal cavity, with the gall-bladder and the cystic artery on the inferior surface of its right lobe.

The round ligament of the liver and the falciform ligament have been pulled over the right costal arch and have been fixed to the wall of the thorax. From the point of attachment the round ligament runs downwards and backwards to the umbilical fossa of the liver, and the falciform ligament extends backwards to the anterior and upper surfaces of the liver.

Below and to the left of the liver is the stomach, which is connected to the liver by a fold of peritoneum called the lesser omentum. From the lower border of the stomach the greater omentum hangs down in front of the contents of the lower part of the abdominal cavity.

The anterior layer of the lesser omentum has been removed along the upper or lesser curvature of the stomach, to display the right and left gastric vessels, which lie between the two layers; and it has been removed also along the right or free margin of the omentum, to display the hepatic artery and its branches, the portal vein and the bile duct, the cystic duct and the common hepatic duct.

By the displacement downwards of the pyloric end of the stomach, the gastro-duodenal branch of the hepatic artery has been brought into view.

The anterior layer of the greater omentum has been removed along the lower part of the greater curvature of the stomach to display the right and the left gastro-epiploic vessels.

1. Falciform ligament.
2. Ligamentum teres.
3. Left hepatic artery.
4. Left hepatic duct.
5. Common hepatic duct.
6. Cystic artery.
7. Fundus of gall-bladder.
8. Cystic duct.
9. Bile duct.
10. Gastro-duodenal artery.
11. Duodenum, descending part.
12. Right gastro-epiploic vessels.
13. Face of section of left lobe of liver.
14. Caudate lobe, seen through lesser omentum.
15. Left gastric artery.
16. Right hepatic artery.
17. Portal vein.
18. Hepatic artery.
19. Lesser omentum.
20. Right gastric vessels.
21. Left gastro-epiploic artery.
22. Stomach.
23. Greater omentum.

artery to its origin from the *hepatic artery* and follow the latter upwards, in the right border of the lesser omentum, to its division into right and left branches immediately below the porta hepatis. On the walls of the artery some of the fibres of the hepatic plexus of sympathetic nerves may be recognised, and at its side some of the *biliary lymph glands* may be seen. Clean both terminal branches of the hepatic artery carefully, especially the right branch, which passes either anterior or posterior to the hepatic duct. To the right of the hepatic artery find the *bile duct*; trace it downwards to the point where it disappears behind the first part of the duodenum, and upwards to the upper border of the lesser omentum, where it is formed by the union of the *common hepatic duct* with the *cystic duct*. Follow the cystic duct to the neck of the gall-bladder, noting that it makes an S-shaped bend. Continue the incision already made in the gall-bladder into the cystic duct and note that the spiral arrangement of the mucous membrane is continued into the duct. Follow the common hepatic duct upwards into the porta hepatis, to the point where it is formed by the union of the *right* and *left hepatic ducts*, which come respectively from the right and left lobes of the liver. Clean away the areolar tissue from between the hepatic artery and the bile duct and display the *portal vein*, which lies behind them. Trace it upwards to its division into right and left branches at the porta hepatis, and downwards to the first part of the duodenum, where it disappears from view at the present stage of dissection. Note that the portal vein lies immediately in front of the epiploic foramen (Winslow), and that its posterior surface is covered by the peritoneum of the anterior margin of the foramen.

Omentum Majus (The Greater Omentum). — After the dissector has displayed and studied the structures situated between the two layers of the lesser omentum he should examine the greater omentum, which hangs down, like an apron, in front of the viscera which lie in the lower part of the abdomen. It is a double fold of peritoneum and consists, therefore, of two anterior and two posterior layers, the former being separated from the latter by a portion of the cavity of the omental bursa. The upper margins of the anterior two layers are attached to the lower part of the greater curvature of the stomach, where they become continuous with the peritoneum on the anterior and posterior surfaces of that viscus. To the left and above, the anterior two layers are continuous with the two layers of the gastro-splenic ligament, but at a lower level the anterior two layers become continuous with the posterior two layers at the free left border. Similarly at the lower and the right margins of the greater omentum the anterior two layers become continuous with the posterior two layers. The upper margins of the posterior two layers are attached to the lower border of the transverse colon, and, through the

PLATE XIII

FIG. 132.

PLATE XIII

FIG. 132.—Dissection of the Abdomen to display the Posterior Wall of the Omental Bursa and some of its relations; a stage further of the dissection shown in Fig. 131.

The greater part of the left lobe of the liver has been removed and the remainder of the liver has been displaced upwards and to the right. The round ligament of the liver and the falciform ligament have been stitched to the right costal arch. All the lesser omentum, except the posterior layer of its right free margin, has been removed or turned aside.

The greater omentum has been detached from the lower part of the greater curvature of the stomach and a large segment of the wall formed by its anterior two layers has been removed.

The stomach has been divided near its pyloric end and afterwards turned upwards and to the left under cover of the left costal arch, to the margin of which the divided end has been fastened.

A portion of the peritoneal layer which forms the upper part of the posterior wall of the omental bursa has been removed to display a part of the pancreas.

The posterior wall of the omental bursa, which is displayed, is formed from below upwards by—(1) the posterior two layers of the greater omentum. (2) The transverse colon, enclosed between two layers of peritoneum which are continuous below with the posterior two layers of the greater omentum and above with the two layers of the transverse meso-colon. (3) The transverse meso-colon, formed by two layers of peritoneum of which only the upper or anterior is visible in the figure. (4) The ascending layer of the transverse meso-colon, which is the upward prolongation of the upper layer of the transverse meso-colon across the anterior surface of the pancreas to the diaphragm.

1. Cut surface of left lobe of liver.
2. Falciform ligament.
3. Ligamentum teres.
4. Left hepatic artery.
5. Right hepatic artery.
6. Common hepatic duct.
7. Cystic duct.
8. Fundus of gall-bladder.
9. Bile duct.
10. Duodenum, junction of superior and descending parts.
11. Transverse colon.
12. Cut edge of anterior wall of omental bursa.
13. Stomach.
14. Part of greater omentum.
15. Cut edge of lesser omentum.
16. Lesser omentum.
17. Caudate lobe of liver.
18. Stomach.
19. Left gastro-pancreatic fold.
20. Left gastric artery.
21. Right inferior phrenic artery.
22. Hepatic artery, in right gastro-pancreatic fold.
23. Pancreas.
24. Left gastro-epiploic artery.
25. Splenic artery.
26. Gastro-duodenal artery.
27. Superior pancreatico-duodenal artery.
28. Right gastro-epiploic artery.
29. Transverse meso-colon.
30. Posterior wall of omental bursa.
31. Anterior two layers of greater omentum.

peritoneum on the anterior and posterior surfaces of the latter, they become continuous with the two layers of the transverse meso-colon, which attaches the transverse colon to the structures lying on the posterior wall of the abdomen. The contents of the greater omentum are—(1) a portion of the cavity of the omental bursa which separates the anterior two layers from the posterior two layers; (2) between the anterior two layers, along the lower border of the stomach, the right and left gastro-epiploic blood vessels and their branches, with lymph vessels and small lymph glands; (3) between the posterior two layers lie small branches of the middle colic artery, which have crossed the surfaces of the transverse colon and are descending into the lower border of the greater omentum, where, in very favourable circumstances, their anastomoses with descending branches of the gastro-epiploic arteries may be seen.

Dissection.—Take away the more superficial of the anterior two layers of the greater omentum along the lower border of the stomach and expose the gastro-epiploic arteries. Trace the left artery to the left to the gastro-splenic ligament, and note that it passes forwards to the stomach between the two layers of that ligament. At a later stage it will be followed to the splenic artery, from which it springs. Trace the right artery to the right to the point where it springs from the gastroduodenal artery at the lower border of the first part of the duodenum.

Remove the anterior two layers of the greater omentum (see Fig. 132). This part of the dissection is not always easy to accomplish, for not uncommonly the posterior of the anterior two layers is fused with the anterior of the posterior two layers, the lower part of the cavity of the omental bursa being obliterated; but if the dissector commences near the left end of the lower border of the stomach he will usually find the cavity persistent. First, he should pull the lower border of the stomach forwards, and cut through the anterior two layers of the omentum below the left gastro-epiploic artery; next, he should introduce his fingers through the opening and gradually separate the anterior two layers from the posterior two layers; then he must enlarge the opening, and, after separating the anterior from the posterior layers as far as possible, he must cut away the anterior layers. After that portion of the dissection is completed he must introduce one hand into the cavity of the omental bursa and he will find that he can pass it upwards behind the stomach and behind the posterior surface of the lesser omentum to the liver. If now he turns his fingers to the right he will be able to pass them behind the portal vein and through the epiploic foramen into the great sac. He should note, as he passes his hand upwards, that the cavity of the omental bursa is constricted, between the œsophagus above and to the left, and the pylorus below and to the right, by two folds of peritoneum which pass forwards from the posterior wall of the abdomen to the œsophagus and the pylorus respectively. He will find, at a later stage of the dissection, that the two folds are connected with the peritoneum on the anterior surface of the pancreas; they are therefore called the left and right *gastro-pancreatic folds*. The left is produced by the left gastric artery as it passes round the left border of the sac to gain entrance into the lesser omentum, and the right is produced by the hepatic artery as it turns round the right margin of the sac at the lower border of the epiploic foramen (Winslowi).

Next, remove the remainder of the lesser omentum and so open into the upper part of the omental bursa; but take care not to injure the contents of the lesser omentum. First cut through the posterior layer along the left border of the hepatic artery; then carry the incision upwards along the margin of the fossa for the ductus venosus. Finally cut through the posterior layer for a short distance along the lesser curvature of the stomach, along the left gastric artery, and turn the separated portion of the lesser omentum to the left over the stomach. Again introduce the hand from the lower part into the upper part of the omental bursa and examine again the constriction of the cavity between the œsophageal and pyloric ends of the stomach, and the gastro-pancreatic folds, which cause it.

It is not possible to make a thorough examination of the cavity of the omental bursa till the stomach, which lies in its anterior wall, has been turned aside. Divide the right gastric artery and the right gastro-epiploic artery immediately to the left of the pylorus, then cut through the stomach in the same situation and turn it over to the left side. The greater part of the anterior wall of the omental bursa is now removed, and the cavity and the remaining boundaries can be examined.

The Cavity of the Omental Bursa extends from the lower margin of the greater omentum below to the liver above, and a narrow, pouch-like recess is prolonged upwards, behind the liver, to the inferior surface of the diaphragm. The posterior wall of the sac is formed, from below upwards, by—(1) the posterior two layers of the greater omentum; (2) the transverse colon, covered with peritoneum; (3) the transverse meso-colon; and, above the line of attachment of the transverse meso-colon to the posterior abdominal wall, by (4) the upper of the two layers of the transverse meso-colon, the so-called "*ascending layer*," which passes upwards, in front of the pancreas, the upper and medial part of the left kidney, the left suprarenal gland and the crura of the diaphragm, to the under surface of the diaphragm, from which it is reflected forwards to the upper part of the posterior surface of the caudate lobe of the liver. The outline of the pancreas can be seen through the thin peritoneum; and the kidney and the suprarenal glands, if not visible, are easily felt.

The narrow, pouch-like upper portion of the cavity of the omental bursa is bounded posteriorly, as already stated, by the peritoneum on the abdominal surface of the crura of the diaphragm; superiorly, by the reflection of the peritoneum forwards to the posterior surface of the liver; anteriorly, by the peritoneum on the posterior surface of a small subdivision of the posterior aspect of the right lobe of the liver called the caudate lobe (O.T. Spigelian); on the left, by the reflection of the posterior layer of the lesser omentum from the margin of the fossa for the ductus venosus to the crura of the diaphragm; and, on the right, by the reflection of the peritoneum from the right crus of the diaphragm to the right lateral margin of the caudate lobe. When the body is recumbent, the recess is the most dependent part of the omental bursa.

The anterior wall of the omental bursa is formed, from above downwards, by the peritoneum on the posterior surface of the caudate lobe of the liver, the lesser omentum, the peritoneum on the posterior surface of the stomach, and by the anterior two layers of the greater omentum.

The left lateral boundary is formed—(1) in the region of the uppermost recess, by the reflection of the peritoneum from the fossa for the ductus venosus to the crura of the diaphragm; at a lower level, posteriorly, by (2) the lieno-renal ligament, which passes from the left kidney to the spleen (see Fig. 136); and anteriorly by (3) the gastro-splenic ligament, which connects the spleen with the stomach; and, at a still lower level, by (4) the union of the anterior two layers with the posterior two layers of the greater omentum at the left free border of the omentum (Fig. 137). The splenic artery runs forwards in the left lateral wall, between the layers of the lieno-renal ligament; and the short gastric branches and the left gastro-epiploic branch of the splenic artery run onwards to the stomach between the layers of the gastro-splenic ligament.

The right lateral wall is formed, from below upwards, by the union of the anterior two layers with the posterior two layers of the greater omentum at its right free border (Fig. 137); next, by the reflection of the posterior of the anterior two layers backwards from the posterior surface of the first part of the duodenum to the front of the pancreas, where it becomes continuous with the ascending layer of the transverse mesocolon (Fig. 136). Immediately above the duodenum the right boundary is absent and the omental bursa communicates with the great sac through the epiploic foramen. Above the epiploic foramen the right margin of the omental bursa is formed, in the upper recess, by the reflection of the peritoneum from the right border of the caudate lobe of the liver to the right crus of the diaphragm. The hepatic artery turns round

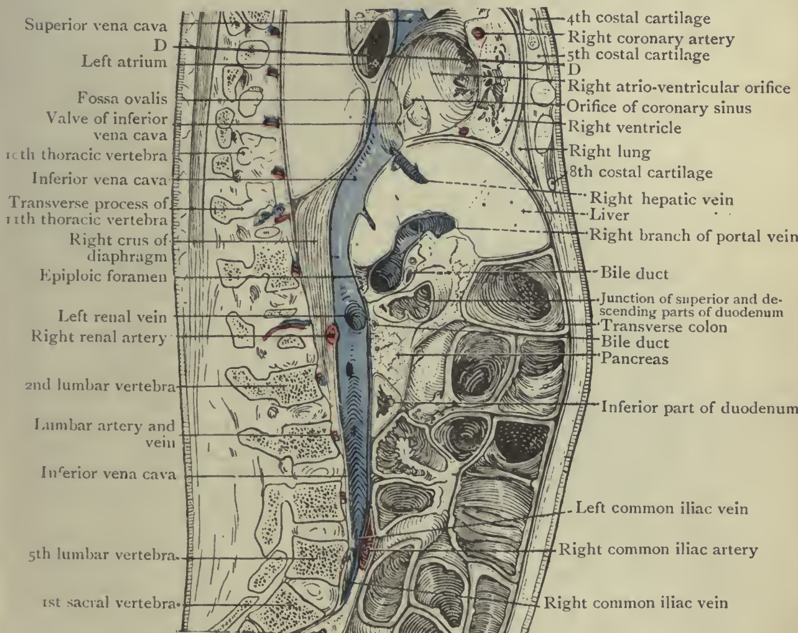


FIG. 133.—Sagittal section of the upper part of the Abdomen and the lower part of the Thorax of a Young Male Adult along the line of the Inferior Vena Cava.

D-D; Plane of Section shown in Fig. 21.

Note that in this subject the lower part of the heart was behind the 7th costal cartilage.

the right border of the bursa immediately behind the upper border of the first part of the duodenum, producing the right gastro-pancreatic fold previously mentioned.

The Great Sac of the Peritoneum.—After the dissector has made himself thoroughly conversant with the cavity of the omental bursa he should study the cavity of the great sac. It is the cavity into which he opened when he cut through the abdominal walls to display the interior of the abdomen. It extends from the diaphragm above to the pelvic floor below (Fig. 134), across the abdomen from one side wall to the other (Fig. 135); and it is divided by the lower part of the

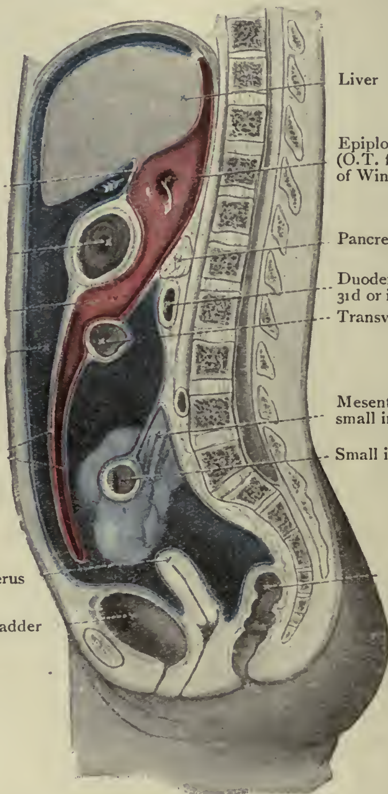


FIG. 134.—Sagittal section of Abdomen showing cavities.

walls of the omental bursa—that is, by the greater omentum, the transverse colon and the transverse meso-colon—into an upper and anterior, and a lower and posterior part, which are continuous with each other round the borders of the greater omentum (see Fig. 137). The upper and anterior part of the sac extends upwards to the lower surface of the diaphragm, where it intervenes between the liver and the diaphragm, and where it is separated into right and left parts by the falciform ligament. The right part of the upper portion extends backwards, between the liver and the diaphragm, to the coronary ligament, which separates the upper surface of the right lobe of the liver from the posterior surface (Fig. 172): the left part of the upper end of the sac passes back-

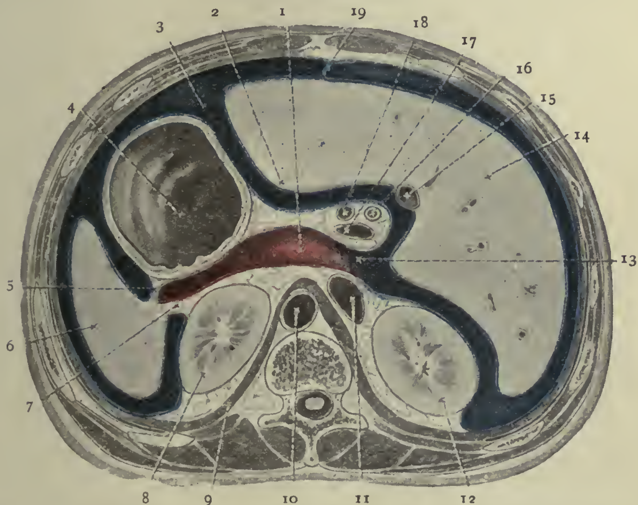


FIG. 135.—Transverse section of Abdomen at the level of the Epiploic Foramen.

1. Omental bursa (O.T. small sac).
2. Omental tubercle of liver.
3. Great sac.
4. Stomach.
5. Gastro-splenic ligament (O.T. gastro-splenic omentum).
6. Spleen.
7. Lieno-renal ligament.
8. Left kidney.
9. Diaphragm.
10. Aorta.
11. Inferior vena cava.
12. Right kidney.
13. Epiploic foramen (O.T. foramen of Winslow).
14. Liver.
15. Gall-bladder.
16. Bile duct.
17. Portal vein.
18. Hepatic artery.
19. Falciform ligament.

wards, over the upper surface of the left lobe of the liver, to the left triangular ligament. Below the free margin of the falciform ligament the upper and anterior part of the great sac extends, as a continuous cavity, from side to side, and it projects backwards, on each side, deeply into the hypochondriac, lumbar, and iliac regions (see Figs. 136 and 137). The backward extensions of the great sac form two deep gutters, one on each side, in which collections of fluid may become lodged when the body is lying recumbent. The lateral boundary of each of the gutter-like recesses is the side wall of the abdomen, formed superiorly by the diaphragm, which separates the peritoneal gutter from the lower part of the pleural sac, and inferiorly by the flat muscles of the abdomen. The medial wall of the right gutter is formed by the right kidney and the ascending colon (see Figs. 136

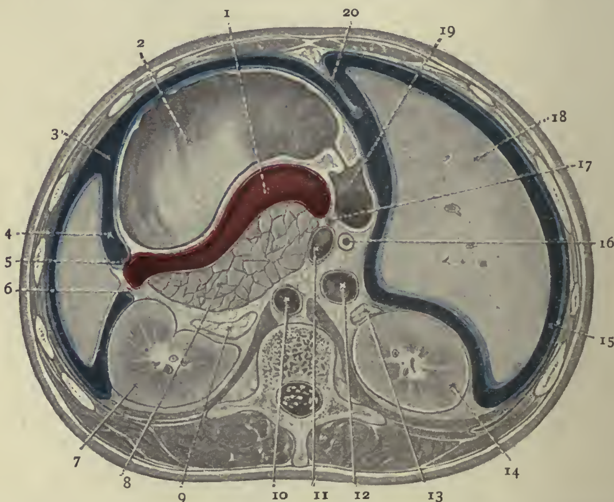


FIG. 136.—Transverse section of Abdomen immediately below the Epiploic Foramen.

1. Omental bursa (O.T. small sac).
2. Stomach. 3. Great sac. 4. Great sac.
5. Gastro-splenic ligament (O.T. gastro-splenic omentum).
6. Lieno-renal ligament.
7. Left kidney.
8. Pancreas.
9. Left suprarenal gland.
10. Aorta. 11. Portal vein.
12. Inferior vena cava.
13. Right suprarenal gland.
14. Right kidney.
15. Great sac.
16. Bile duct.
17. Gastro-duodenal artery.
18. Liver.
19. Duodenum, 1st part.
20. Falciform ligament.

and 137); and the medial wall of the left gutter by the lieno-renal ligament and left kidney above and by the descending colon below (see Figs. 136 and 137).

The dissector should pass his hand, from above downwards, along each lateral gutter of the great sac, and he will find that it is divided by a transverse fold of the peritoneal wall into an upper and a lower part, but the division occurs at very different levels on the opposite sides. The fold which separates the upper from the lower part of the left gutter is the phrenico-colic ligament, which lies at the level of the eleventh rib in the mid-axillary line. On the right side the dividing fold is placed much lower and is frequently less distinct. It passes from the side wall of the abdomen, in the upper part of the iliac region, to the lateral wall of the lower part of the ascending colon. The lateral gutters and the folds

FIG. 137.—Transverse section of Abdomen through the fourth lumbar vertebræ.

1. Small intestine.
2. Greater omentum and omental bursa.
3. Descending colon.
4. Aorta.
5. Inferior vena cava.
6. Ascending colon.
7. Great sac.
8. Omental bursa (O.T. small sac).
9. Great sac.
10. Mesentery.

which divide them are of importance because they tend to localise abnormal collections of blood or inflammatory effusions which may be in the cavity of the great sac; and the dissector should note that in the recumbent posture the lowest part of each lateral gutter is situated at the level of the upper part of the kidney, in the region of the last intercostal space.

The upper portion of the posterior part of the cavity of the great sac—the part behind the greater omentum—also is divided, in the upper part of its extent, into two parts, by the mesentery of the small intestine, which runs obliquely from the left side of the second lumbar vertebra to the right iliac fossa. The upper boundary of each subdivision of the posterior and lower part of the cavity of the great sac is the transverse meso-colon (Fig. 134). The lateral boundary of the right part

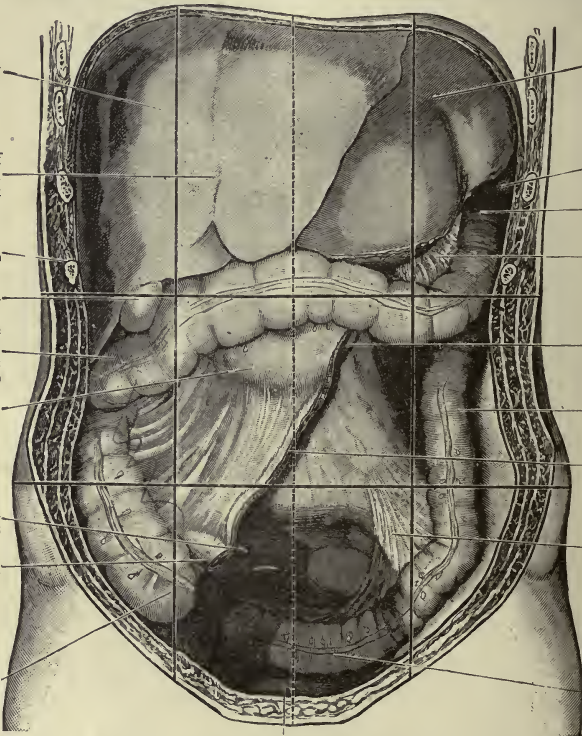


FIG. 138.—Abdominal viscera after removal of jejunum and ileum. (Birmingham.)

is the ascending colon, and of the left part the descending colon (Fig. 137). The lateral gutter of the right part of the posterior portion of the great sac terminates below at the union of the ileum with the large intestine (see Fig. 138); and the lateral gutter on the left side is continued downwards into the pelvis between the mesentery of the small intestine and the mesentery of the pelvic colon.

The lower portion of the posterior part of the cavity of the great sac lies upon the floor of the pelvis, and, in the male, it forms three definite pouches: a median, and a right and left lateral pouch. The median or recto-vesical pouch is bounded in front by the bladder, behind by the rectum, and laterally, on each side, by a sacro-genital fold of peritoneum, which passes from the region of the fundus of the bladder, past the side of the rectum, to the sacrum. Each of the two lateral pouches is bounded medially by the side of the bladder and the sacro-genital fold, and laterally by the side wall of the pelvis. In the female, by the interposition of the uterus and the upper part of the vagina, between the bladder and the rectum, two median pouches are formed —a larger posterior pouch, the *recto-uterine pouch* (*pouch of Douglas*), and a smaller anterior pouch, the *utero-vesical pouch*; and the broad ligament, which connects the lateral border of the uterus with the side wall of the pelvis, divides each of the single lateral pouches present in the male into an anterior or *paravesical pouch*, and a posterior part, the *lateral pouch of Douglas*, in which the ovary and the termination of the oviduct are situated.

Peritoneum.—The peritoneum is the great serous membrane which forms the wall of the peritoneal cavity. Externally it is blended with the subserous or extra-peritoneal tissue of the abdomen, in which the vessels and visceral nerves of the abdomen lie. Internally it is covered with a flat, glistening epithelium. In the male, the cavity of the peritoneal sac is closed; that is, it does not communicate with the exterior of the body. In the female, on the other hand, it does communicate with the exterior through the female genital passages, viz. the uterine tubes, the uterus, and the vagina.

When the abdomen was opened the cavity of the peritoneum also was opened, and the dissector's attention was drawn to the smooth and glistening appearance of the inner surface of the serous membrane which is due to the lining epithelium. As the examination of the cavity proceeded the dissector must have noted that the peritoneum gave more or less complete coverings to the various abdominal viscera, and that its posterior wall was raised into numerous complicated folds. The folds are the result of the invagination of the wall of the sac by the adjacent viscera, and the complication of the folds has been produced by changes in form and position of the viscera, and by the fusion and partial disappearance of some of the primitive folds.

The portion of the peritoneum which lines the inner surface of the abdominal wall is called *parietal peritoneum.* The portion which covers the viscera is termed *visceral peritoneum*; and the folds which connect the viscera with each other or with the wall of the abdomen are defined as omenta, mesenteries, and ligaments.

The term *mesentery* is *generally* applied to folds of peritoneum which connect portions of the intestine with the posterior wall of the abdomen.

The term *omentum* has usually been applied, in English terminology, to folds of peritoneum which connect the stomach with other viscera. The term *ligament* was limited to any fold which did not fall into either of the two first divisions; now, however, it is becoming customary to extend the term to folds and portions of folds which connect the stomach to adjacent viscera; thus the lesser omentum is said to consist of the *hepato-gastric* and the *hepato-duodenal ligaments*, the two terms being applied respectively to the parts which connect the liver to the stomach and the liver to the duodenum. The gastro-splenic omentum becomes the *gastro-splenic ligament*, and the greater omentum is sometimes spoken of as the *gastro-colic ligament.*

The relations of the layers of the visceral and parietal peritoneum to each other, and the relations of the layers which bound the omental bursa to those which limit the cavity of the great sac, can be easily followed in Figs. 134, 135, 136, and 137. The dissector should study the figures and confirm their accuracy by following the peritoneum in his "part" at the levels, and in the planes, indicated in them.

Dissection.—After examining the various parts of the peritoneal cavity, and the different folds of the peritoneal membrane, the dissector should remove the peritoneum of the posterior wall of the omental bursa, above the level of the root of the transverse meso-colon. Commence immediately above the line of attachment of the transverse meso-colon to the lower border of the pancreas, which can be seen through the thin peritoneum, and work upwards, taking care not to injure either the pancreas itself or the blood-vessels which lie behind the posterior wall of the upper part of the omental bursa. Remove also the medial layer of the gastro-splenic ligament, and the medial layer of the lieno-renal ligament. The object of this dissection

PLATE XIV

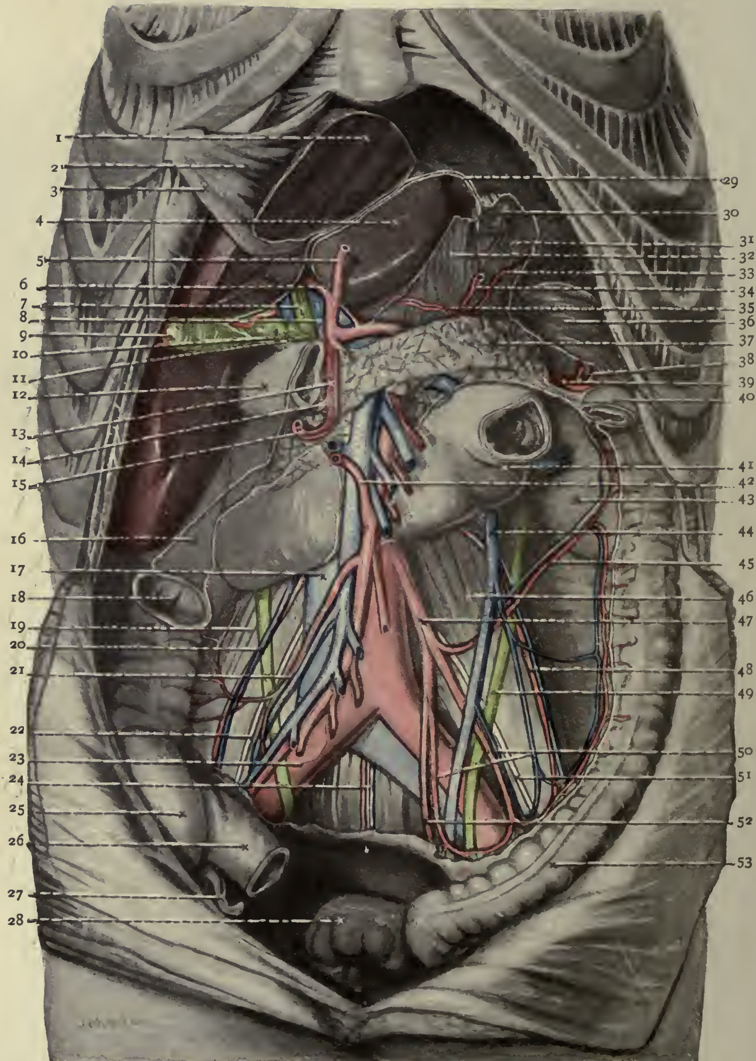


FIG. 139.

PLATE XIV

FIG. 139.—Further Stage of the Dissection of the Abdomen.

The œsophagus and the gastro-phrenic ligament have been divided close to the diaphragm.

The gastro-splenic ligament has been divided close to the hilum of the spleen.

The transverse meso-colon has been divided close to its attachment to the duodenum and the pancreas.

The transverse colon has been divided close to the right and left colic flexures; and the stomach and the transverse colon, with the greater omentum and its contained part of the omental bursa, have been removed.

The jejunum has been divided close to the duodeno-jejunal flexure, and the ileum close to the cæcum, and the intervening part of the small intestine and its mesentery have been removed. The peritoneum has been taken away from the upper part of the posterior wall of the pelvis minor, and from the area on the posterior wall of the abdomen which is bounded by the cæcum and the ascending colon on the right, and the descending and iliac portions of the colon on the left.

The peritoneum of the posterior wall of the upper part of the omental bursa has also been removed.

By the removal of the posterior wall of the upper part of the omental bursa, the body and tail of the pancreas, the crura of the diaphragm, the left inferior phrenic artery and a portion of the splenic artery have been displayed.

By the removal of the transverse colon and the greater part of the small intestine, the transverse and ascending portions of the inferior part of the duodenum have been brought into view; and, by the removal of the peritoneum from the posterior wall of the lower part of the abdomen, the ureters, and the vessels, nerves, and muscles lying immediately behind the peritoneum in that region, have been exposed.

1. Cut surface of left lobe of liver.
2. Falciform ligament.
3. Ligamentum teres.
4. Caudate lobe.
5. Left hepatic artery.
6. Right hepatic artery.
7. Hepatic duct.
8. Portal vein.
9. Fundus of gall-bladder.
10. Cystic duct.
11. Bile duct.
12. Duodenum, superior part.
13. Gastro-duodenal artery.
14. Sup. pancreatico-duodenal artery.
15. Right gastro-epiploic artery.
16. Right kidney.
17. Inferior vena cava.
18. Right flexure of the colon.
19. Psoas major muscle.
20. Spermatic vessels crossing ureter.
21. Common trunk of ileo-colic and right colic arteries.
22. Genito-femoral nerve.
23. Right common iliac artery.
24. Middle sacral vessels.
25. Cæcum.
26. Ileum.
27. Vermiform process.
28. Pelvic colon.
29. Cut edge of lesser omentum.
30. Œsophagus.
31. Left crus of diaphragm.
32. Right crus of diaphragm.
33. Left inferior phrenic artery.
34. Left gastric artery.
35. Right inferior phrenic artery.
36. Spleen.
37. Pancreas.
38. Left gastro-epiploic artery.
39. Splenic artery.
40. Left flexure of the colon.
41. Duodeno-jejunal flexure.
42. Middle colic artery.
43. Left kidney.
44. Inferior mesenteric vein.
45. Left colic artery.
46. Psoas major muscle.
47. Inferior mesenteric artery.
48. Spermatic vessels.
49. Ureter.
50. Sigmoid arteries.
51. Genito-femoral nerve.
52. Superior hæmorrhoidal artery.
53. Iliac colon.

is to display — (1) the anterior surface of the body, the neck, and part of the head of the pancreas ; (2) a part of the anterior surface of the left kidney ; (3) the anterior surface of the left suprarenal gland ; (4) the left cœliac ganglion and the left greater splanchnic nerve ; (5) the upper part of the abdominal portion of the aorta ; (6) the cœliac artery and its branches, viz. the hepatic, the splenic, and the left gastric artery—and their branches ; (7) the inferior phrenic arteries ; (8) the upper parts of the crura of the diaphragm ; (9) the terminal part of the right vagus nerve.

Clean the pancreas first, and do not disturb it from its position. At the upper border of the pancreas, in the median plane, and below the caudate lobe of the liver, find the cœliac artery, dividing into its three terminal branches : the hepatic, running to the right ; the splenic, to the left along the upper border, or immediately behind the upper border, of the pancreas, and the left gastric, running upwards and to the left to the junction of the œsophagus with the stomach. Trace the first portion of the hepatic artery, through the right gastro-pancreatic fold, to the right free margin of the omentum, where it has already been exposed, and, if possible, preserve the sympathetic nerve filaments which surround it. Secure its *gastro-duodenal branch*, which descends behind the first part of the duodenum and in front of the neck of the pancreas, and trace it to its division into the superior *pancreatico-duodenal* and the *right gastro-epiploic arteries*. Trace the latter to the left to the point where the stomach was divided. Trace the *splenic artery* to the left, to the anterior surface of the left kidney, and then forwards, along the left layer of the lieno-renal ligament, which is still *in situ*, to the spleen, and note that before it reaches the spleen it gives off a number of *short gastric branches*, and the *left gastro-epiploic artery*, which run forwards to the stomach, along the left layer of the gastro-splenic ligament, which also is still in position. Note, further, that the splenic artery breaks up into branches before it reaches the spleen. In many cases the short gastric branches and the left gastro-epiploic artery spring from the terminal branches, and not from the trunk of the splenic artery. Secure also the branches from the splenic artery to the pancreas, and, if possible, preserve the sympathetic nerve plexus which surrounds the artery. Follow the *left gastric artery*, through the left gastro-pancreatic fold, to the junction of the œsophagus with the stomach, where the artery gives off its œsophageal branch or branches ; secure also the accompanying vein, *the coronary vein of the stomach*, and trace it, across the median plane, to its union with the portal vein at the lower end of the right free margin of the lesser omentum. Trace the *cœliac artery* backwards to its origin from the front of the aorta, and do not injure the plexus of sympathetic nerve filaments which surrounds it.

Immediately to the left of the cœliac artery, and at the upper border of the pancreas, find the *left cœliac ganglion*, which is connected with the plexus of nerves round the root of the cœliac artery. Follow the ganglion upwards and backwards to its union with the left greater splanchnic nerve. Immediately to the left of the ganglion find the *left suprarenal gland*, and, below it, the upper and medial part of the anterior surface of the *left kidney*.

Find the inferior phrenic arteries, one on each side, immediately above the level of the cœliac artery; trace each medially to its origin from the aorta, and laterally across the surface of the corresponding crus of the diaphragm; note that the left passes behind the œsophagus; the right passes behind the inferior vena cava, but the two facts cannot be demonstrated until a later period.

Clean the posterior surface of the abdominal part of the œsophagus and secure the *right vagus nerve* which runs downwards upon it; trace the branches of the vagus along the wall of the stomach and towards the spleen. Finally, clean the crura of the diaphragm to the level of the orifice through which the œsophagus enters the abdomen.

When the dissection is completed the dissector is in a position to study the cœliac artery and its branches, the blood supply of the stomach, and the bed of the stomach.

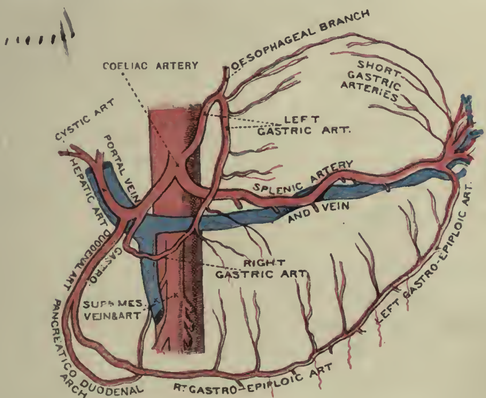


FIG. 140.—The Cœliac Artery and its branches.

Arteria Cœliaca (O.T. **Cœliac Axis**).—The cœliac artery is a short, wide vessel, which springs from the front of the aorta, between the two crura of the diaphragm, immediately above the upper margin of the pancreas. It is directed horizontally forwards, and, after a course of little more than 12·5 mm. (half an inch), divides into three branches, viz.—(1) the left gastric; (2) the hepatic; and (3) the splenic—which radiate from each other like the spokes of a wheel. The hepatic and splenic branches are large, but the left gastric branch is relatively small.

The cœliac artery is surrounded by a thick, matted plexus of nerves, called the *cœliac plexus*, which sends numerous nerve twigs with the three branches of the artery.

Arteria Gastrica Sinistra (O.T. Coronary Artery).—The left gastric artery is the smallest of the three branches of the cœliac artery; it proceeds upwards and to the left, behind the omental bursa and through the left gastro-pancreatic fold, to the œsophageal opening of the stomach, where it changes its direction, enters between the two layers of the lesser omentum, and runs, from above downwards and to the right, along the lesser curvature of the stomach. Near the pylorus it ends by anastomosing with the *right gastric branch* of the hepatic artery.

The branches of the left gastric artery are:—

1. Œsophageal.
2. Gastric.

Rami Œsophagei.—Two or three œsophageal branches may arise separately, or by a common trunk, from the left gastric artery at the point where it reaches the stomach. They pass upwards, through the œsophageal opening of the diaphragm, upon the posterior aspect of the gullet, and anastomose with the œsophageal branches of the thoracic aorta.

The *gastric branches* take origin from the trunk, as it runs along the lesser curvature of the stomach, and are distributed to both surfaces of this viscus.

Vena Coronaria Ventriculi.—The coronary vein of the stomach accompanies the left gastric artery, along the lesser curvature of the stomach and behind the omental bursa, to the cœliac artery; then, continuing to the right, it crosses in front of the aorta and joins the portal vein at the lower border of the epiploic foramen.

Arteria Hepatica.—The hepatic artery is intermediate in size between the left gastric and the splenic. At first it runs transversely to the right, along the upper border of the pancreas. At the pylorus it changes its direction, and turns forwards, below the epiploic foramen, in the right gastro-pancreatic fold; then it ascends between the two layers of the lesser omentum. Near the porta hepatis it ends by dividing into *right* and *left hepatic arteries*. The hepatic artery is accompanied by numerous large nerve twigs derived from the cœliac plexus, and, as it passes upwards to the liver, it is in close relationship with the bile duct and the portal vein. The duct lies upon the right side of the artery, and the vein lies behind both. (Fig. 135, p. 291, and Fig. 139, p. 297.)

The following are the branches of the hepatic artery:—

1. A. gastrica dextra.
2. A. gastro-duodenalis. { A. pancreatico-duodenalis superior. / A. gastro-epiploica dextra.
3. A. hepatica propria. { Ramus dextra. { A. Cystica. / Ramus sinistra.

The *right gastric artery* (O.T. *pyloric*) is a small artery which springs from the hepatic artery at the pylorus, and then runs from right to left, along the lesser curvature of the stomach, between the two layers of the lesser omentum. It ends by inosculating with the left gastric; the accompanying vein terminates in the portal vein.

The *gastro-duodenal artery* arises close to the right gastric artery. It descends, behind the first part of the duodenum, in a groove on the anterior aspect of the neck of the pancreas. At the lower border of the duodenum it ends by dividing into the superior pancreatico-duodenal and right gastro-epiploic branches (Fig. 140).

The *superior pancreatico-duodenal artery* runs first to the right, and then downwards between the head of the pancreas and the duodenum. It anastomoses with the *inferior pancreatico-duodenal branch* of the superior mesenteric artery, forming an arch round the head of the pancreas. It gives branches to both the duodenum and the pancreas. The pancreatico-duodenal veins join the superior mesenteric vein.

The *right gastro-epiploic artery* is directed from right to left, along the greater curvature of the stomach, between the anterior two layers of the greater omentum. It gives branches upwards to both surfaces of the stomach, and downwards to the greater omentum; and it ends by anastomosing with the *left gastro-epiploic* branch of the splenic artery. The right gastro-epiploic vein joins the superior mesenteric vein.

The *right* and *left hepatic arteries*, the terminal branches of the hepatic, diverge from each other, and sink into the liver at the two extremities of the porta hepatis. From the right hepatic a small branch, called the *cystic*, is given to the gall-bladder. The cystic artery divides into two twigs; one of the two ramifies in the areolar tissue between the over and gall-bladder, and the other upon the inferior surface of the gall-bladder, between the gall-bladder and its peritoneal covering.

The *cystic vein* joins the vena portæ or its right branch.

Arteria Lienalis. — The splenic artery is the largest branch of the cœliac artery. It takes a wavy or tortuous course towards the left side, along the upper border of the pancreas, behind the omental bursa; and it ends, in front of the left kidney, by dividing into five or six branches, which enter the hilum of the spleen.

It is accompanied by the splenic vein, which, however, lies at a lower level, and therefore altogether behind the pancreas.

The following are the branches of the splenic artery:—

1. Arteriæ pancreaticæ.
2. Aa. gastricæ. { Aa. gastricæ breves. / A. gastro-epiploica sinistra.
3. Rami lienales.

The *pancreatic arteries* are small twigs which come off at various points for the supply of the pancreas.

The *pancreatica magna branch*, which is sometimes described as accompanying the duct from left to right in the substance of the pancreas, is more commonly absent than present.

The *short gastric arteries* (O.T. *Vasa Brevia*) are five or six small arteries, of which some arise directly from the splenic, whilst others take origin from its terminal branches. They run towards the stomach, between the two layers of the gastro-splenic ligament, and are distributed to the cardiac part of the viscus (see p. 299), anastomosing with the left gastric and left gastro-epiploic arteries.

The *left gastro-epiploic artery* takes origin from the splenic, near the spleen, or from one of its terminal branches. It runs forwards, in the gastro-splenic ligament, and then turns to the right, along the greater curvature of the stomach, between the anterior two layers of the greater omentum, and it ends by anastomosing with the right gastro-epiploic artery. Some of its branches ascend, others descend. The ascending branches supply both surfaces of the stomach, and they anastomose with branches of the right and left gastric arteries and with the short gastric arteries. The descending branches pass downwards, between the two anterior layers of the greater omentum, and they may anastomose with branches of the middle colic artery.

The *splenic* or *terminal branches* of the splenic artery pass from the lieno-renal ligament into the hilum of the spleen.

From the above description of the branches of the cœliac artery it will be seen that the stomach is remarkably rich in blood-vessels. *Two* proceed from *left to right*—viz. the *left gastric*, along the lesser curvature, and the *left gastro-epiploic*, along the greater curvature; *two*, both branches of the hepatic, are directed from *right to left*—viz. the *right gastric*, in relation to the lesser curvature; and the *right gastro-epiploic*, in relation to the greater curvature. The arterial circle is completed on the left by the *short gastric arteries*, which connect the left gastric artery with the left gastro-epiploic.

The splenic vein, the portal vein, the bile duct, and the inferior phrenic arteries will be considered at a later stage of the dissection.

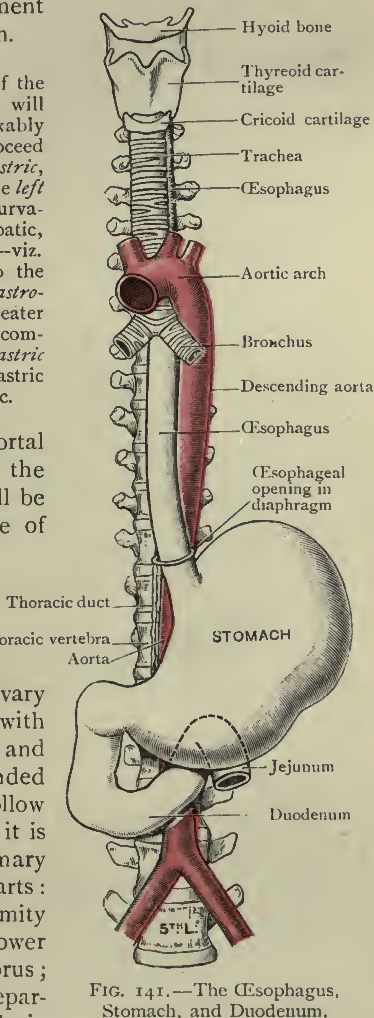


FIG. 141.—The Œsophagus, Stomach, and Duodenum.

Ventriculus.—The stomach is the most dilated section of the alimentary canal. Its size, shape and position vary considerably in association with the amount of its contents, and with the empty or distended condition of the adjacent hollow viscera, but, on the whole, it is pear-shaped, and it is customary to recognise the following parts: (1) a blunt left upper extremity or fundus; (2) a narrow lower and right extremity or pylorus; (3) an intermediate part separated into cardiac and pyloric portions; (4) two orifices, an œsophageal and a pyloric; (5) two surfaces, a superior and an inferior; (6) two borders or curvatures, a greater and a lesser.

It receives food through the œsophagus or gullet, which opens into the stomach at the upper end of the lesser curvature, below and to the right of the fundus, whilst at its lower, and right or pyloric extremity, it becomes continuous with the duodenum, which is the first part of the small intestine.

The *fundus* is full and rounded, and forms a marked bulging directed upwards and backwards. It occupies the back part of the left cupola of the diaphragm, from which it is partially separated by the spleen and the liver.

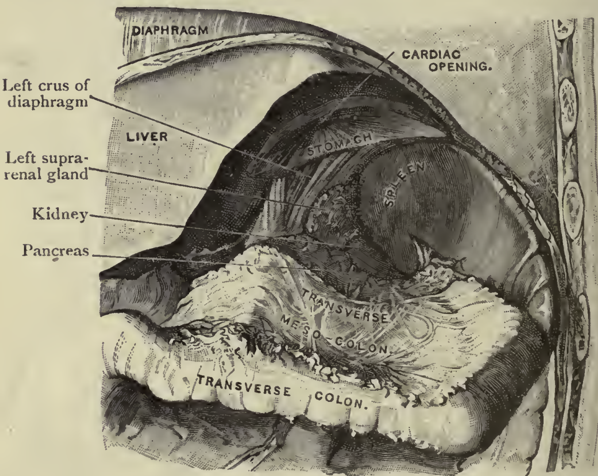


FIG. 142.—The Stomach has been removed from its bed so as to display the recess in which it lies.

The *œsophageal or cardiac orifice* is situated to the right of the fundus and about 50 mm. (two inches) below its summit. It lies at the upper end of the lesser curvature, but in certain conditions appears to be partly on the upper surface.

The *pylorus*, or narrow right extremity of the stomach, is, as a rule, directed backwards. It is continuous with the duodenum or commencement of the small intestine, the line of junction being marked, on the surface, by a slight but obvious constriction, termed the *duodeno-pyloric constriction*.

The two surfaces of the stomach, as a general rule, look for the most part upwards and downwards. The *upper surface* is fuller and more convex than the lower surface. It is directed forwards, as well as upwards, and is covered, to a large extent, by the left lobe of the liver. Below and to the left of the sharp margin of the liver, however, a considerable portion of the superior surface of the stomach is in apposition partly with the diaphragm, and partly with the posterior aspect of the anterior abdominal wall.

The *inferior surface* of the stomach is flatter than the superior surface, and is supported by a slightly curved and sloping shelf, which projects forwards from the posterior wall of the abdomen. This has been appropriately called, by

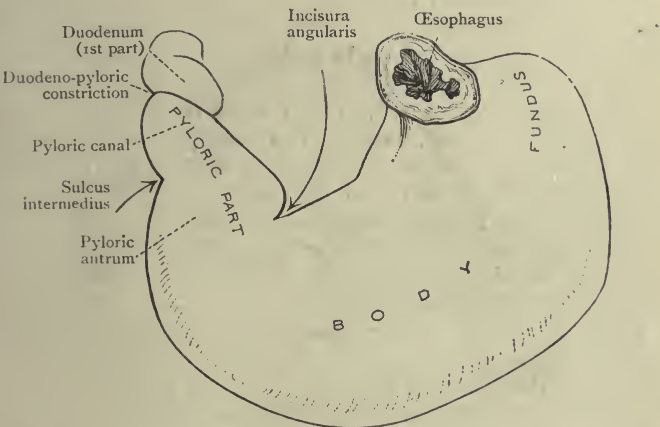


FIG. 143.—Outline of the upper aspect of the Stomach of a Child which has been hardened *in situ* by formalin injection. It is the outline of the upper surface of the stomach figured on p. 269.

Birmingham, the *stomach-bed.* It is formed by the following structures, all of which are related to the lower surface of the organ: (1) the diaphragm; (2) the gastric surface of the spleen; (3) the left suprarenal gland and a varying amount of the upper part of the left kidney; (4) the anterior surface of the pancreas; (5) the transverse meso-colon; and (6) the transverse colon. A niche of the great sac of the peritoneum intervenes between the stomach and the spleen (Fig. 135), and the omental bursa separates it from the left suprarenal gland, the kidney (Fig. 136), the pancreas, and colon, whilst the transverse meso-colon intervenes between it and the coils of the small intestine.

The right, upper, or posterior border of the stomach is termed its *lesser curvature*. It extends from the cardiac orifice to the pylorus, and curves round the base of an eminence on the lower surface of the left lobe of the liver, called the tuber omentale, and also, to a smaller extent, round a corresponding prominence of the pancreas. It is therefore concave, and it is connected to the liver and, to a slight extent, to the diaphragm by the lesser omentum. The left, lower, or anterior border of the stomach, called the *greater curvature* on account of its great length, is convex and is directed to the left and forwards; to its uppermost segment is attached the gastro-phrenic ligament; to its left lateral segment, the gastro-splenic ligament; and to its lowest or anterior segment, the greater omentum.

The stomach is not only curved along its long axis but it is also bent upon itself, more or less acutely. As a result of the bend a notch or angular depression is formed on the lesser curvature; it is called the *incisura angularis*. The presence of the incisura angularis is taken advantage of to divide the organ, for descriptive purposes, into two main parts, the *cardiac part* and the *pyloric part*. The cardiac part lies to the left of an imaginary plane which descends through the long axis of the stomach from the incisura angularis. Occasionally a distinct constriction occurs between the two parts, and the stomach is then said to be bilocular. The cardiac part is subdivided into an upper portion the *fundus*, and a lower portion the *body*. The plane of separation between the two lies at the level of the lower margin of the œsophageal orifice. The pyloric part is also subdivided into the *pyloric antrum* and the *pyloric canal*. The separation between the two segments of the pyloric portion is indicated on the surface of the stomach by a notch on the greater curvature called the *sulcus intermedius*. As a rule the pyloric canal is directed backwards, it is distinctly tubular, and it possesses relatively thick muscular walls, whilst the pyloric antrum is more dilated and its walls are relatively thin. The characteristic features of the two segments of the pyloric portion are not always evident. Occasionally, during digestion, all four segments of the stomach are evident as in the stomach shown in Fig. 122, where the gas-filled fundus, the vertical cylindrical body, and the somewhat bulbous pyloric antrum and the pyloric canal are obvious. In other cases, however, the lines of separation between the body and the pyloric portion, and between the two segments of the pyloric portion, are less evident or are altogether absent (see Figs. 122, 124, 125, 126).

In certain phases of digestion the lower part of the body and the whole of the pyloric portion form together a tubular canal, along which waves of contraction pass to and fro, churning the contents into a unform consistence, whilst the remainder of the body and the fundus form a kind of passive

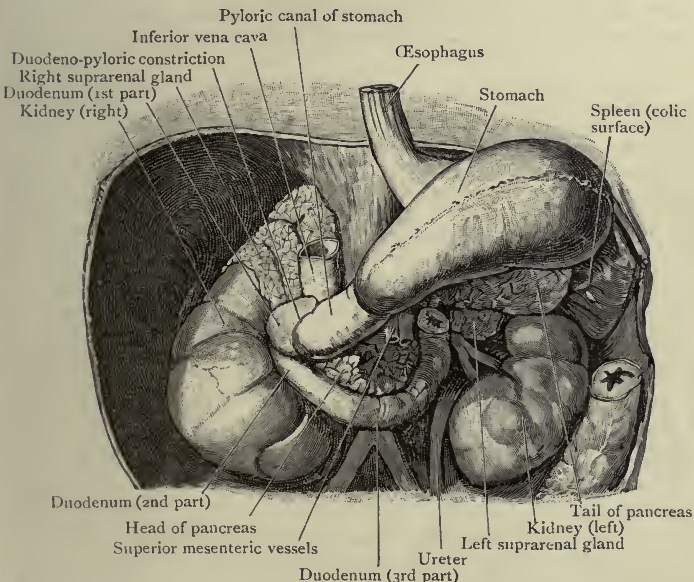


FIG. 144.—Horizontal position of the Stomach in a Child two years old; viscera hardened by formalin injection.

reservoir, from which food is squeezed into the more actively contracting segment, as the thoroughly churned material intermittently escapes thiough the pyloric orifice into the duodenum.

Position of the Stomach.—When *empty* and *contracted* the stomach lies more or less horizontally within the abdominal cavity; it is placed within the left hypochondrium and the left portion of the epigastrium. The organ is bent on itself like a sickle and the fundus looks directly backwards; the surfaces are directed upwards and downwards and the curvatures forwards and backwards—the greater curvature being at a slightly higher level than the lesser curvature; lastly, there is a gradual but decided downward slope of the upper surface from the fundus to the pylorus.

The pyloric extremity of the empty stomach lies in the transpyloric plane (Addison), either where the latter cuts the median plane, or from half an inch to an inch to the right of the median plane. The transpyloric plane is situated midway between the upper margin of the manubrium sterni and the upper margin of the symphysis pubis.

The conditions which give rise to the position and form of the empty stomach as described above are sufficiently obvious when the nature of the chamber within the abdomen which is occupied by the organ is considered. The roof of this chamber, formed by the liver and diaphragm, is more resistant, more unyielding, than the floor, which is formed chiefly by the transverse meso-colon, buoyed up by the movable coils of small intestine. As the stomach becomes empty and contracted, the intestine, acted on by the abdominal wall, rises up and presses it against the sloping visceral surface of the liver, and the slope or gradual descent to the right, which is so characteristic a feature of the upper surface of the empty stomach, is the result.

When the stomach becomes *full*, it may either retain the horizontal position, which is characteristic of the organ when it is empty, or it may assume a more or less oblique position. In both cases, it acquires more space within the abdomen by displacing neighbouring viscera, and the *pylorus* moves to the right, but not as a rule more than 35 to 50 mm. (an inch and a half to two inches) from the median plane. The pylorus does not alter its position in a vertical direction; it maintains the same level within the abdomen. The position of the *œsophageal opening* is only slightly affected by the emptying or the distension of the stomach. It is placed opposite the body of the tenth thoracic vertebra, and on the surface of the body its situation may be indicated by placing the finger on the seventh costal cartilage of the left side about one inch from the median plane.

As the stomach fills it becomes more rounded in general outline, and, should it assume the oblique position when full, the fundus is directed upwards, whilst the surfaces look forwards and backwards; further, the part of the greater curvature opposite the incisura angularis takes a median position and occupies a lower level than any other part of the stomach. It follows from this that the pyloric part of the organ courses upwards and to the right to reach its termination.

While the various conditions which determine the position and form of the full stomach are under consideration, it is necessary to take into account the state of the movable, and as a rule yielding, floor of the stomach chamber. It is possible that the easiest and most natural way for the stomach to expand, under ordinary circumstances, is in a downward direction by intestinal displacement, and when this occurs the oblique portion of the organ is the result. But when the intestines are distended the stomach cannot acquire the necessary space in this manner, and the liver, which forms so large a part of the roof of the stomach chamber, has to give way before it. The obvious result of such a change in the position and form of the pliant liver is that the full stomach retains the horizontal position.

The dissector must remember that the description given above refers to the appearance presented by the stomach fixed and hardened after death when the body is lying on its back. It probably has a very similar form and similar relations during life when the body is recumbent; but when the body is erect the œsophageal orifice and the fundus retain their close relationships to the diaphragm and the pylorus remains at the level of the transpyloric plane, but the lowest part of the greater curvature descends to, or below, the level of the umbilicus, and the upper two-thirds of the organ becomes more tubular and lies more in a vertical plane (Figs. 122, 125).

When the stomach is empty it is questionable if it ever assumes, during life, the flaccid, relaxed, and flattened form which is so frequently seen in the dissecting-room, in subjects which have not been specially hardened. In life, the healthy stomach, by contraction of its muscular coat, adapts itself to its contents whether they are liquid, gaseous, or solid, and when empty and contracted its walls are thick and firm.

The Abdominal Part of the Œsophagus.—The abdominal part of the gullet is very short—probably never more than one inch in length. It lies in the upper and posterior part of the epigastric region, behind a groove in the posterior aspect of the left lobe of the liver, and in front of the left crus of the diaphragm. Its right border passes uniformly and gradually into the lesser curvature of the stomach, without the formation of an angle, but a very definite angle is formed between its left border and the fundus.

Relations between Thoracic and Abdominal Organs.—At this stage it is advisable to consider the relations between the abdominal and thoracic organs which lie upon the different aspects of the diaphragm. It has been noted that the right lobe of the liver occupies the right vault of the diaphragm, whilst the left lobe of the liver, the fundus of the stomach, and the spleen occupy the left vault. The base of the right lung is in relation to the right lobe of the liver. The pericardium, in by far the greater part of its extent, lies above the left lobe of the liver, which therefore intervenes between it and the stomach; only a limited portion of the apex of the heart, which is inside the pericardium, extends over the region of the stomach. The base of the left lung lies over the left lobe of the liver, the fundus of the stomach, and the spleen.

Intestinum Tenue.—The small intestine is that part of the alimentary canal which succeeds the stomach. It begins, in the epigastric region, at the pylorus, and ends, in the upper part of the right iliac region, by joining the large intestine. Its average length is somewhere about seven metres (twenty-three feet). It diminishes slightly in calibre from its commencement to its termination, and it is divided into three portions, viz.:—

1. The duodenum.
2. The jejunum.
3. The ileum.

The *duodenum* is the name which is given to the first part of the small intestine. It is about 25 cm. (ten inches) long, and it extends, in a horse-shoe-shaped curve, from the pylorus to the left side of the body of the second lumbar vertebra. As it lies deeply in the greater part of its extent, and as further dissection is necessary to display its relations, it is not convenient to consider it at present.

The *jejunum* and *ileum* constitute the coils of the small intestine, which, under ordinary circumstances, are more or less completely covered in front by the greater omentum. The jejunum begins where the duodenum ends, viz. at the left side of the body of the second lumbar vertebra; and the ileum ends in the upper part of the right iliac region by joining the large intestine at the upper end of the cæcum. The subdivision of the small intestine is of the most arbitrary kind. It is customary for anatomists to look upon the upper two-fifths of the small intestine beyond the duodenum as being jejunum, and the lower three-fifths as being ileum. There is no hard-and-fast line of demarcation between those two divisions—the one passes insensibly into the other;

and, as the chief distinction is to be found by an examination of the interior of the tube, the student will not in the meantime see much difference between them.

To expose the commencement of the jejunum, the greater omentum, with the enclosed transverse colon, should be thrown upwards over the lower margin of the thoracic wall. The

FIG. 145.—The Mesentery in a subject which was hardened by formalin injection. The jejunum and ileum have been removed, and the foldings of the mesentery are displayed.

coils of the small intestine should then be drawn over to the right. The junction between the duodenum and the jejunum will now be seen on the left side of the vertebral column, at the level of the second lumbar vertebra. The termination of the duodenum is fixed, partly by its relation to the peritoneum and partly by the suspensory muscle of the duodenum, which will be described later (p. 344); the commencement of the jejunum bends suddenly forwards and downwards from it, forming the *duodeno-jejunal flexure.*

The lower coils of the ileum usually lie in the pelvis minor, and the terminal part of the ileum has, as a rule, no great latitude of movement. It ascends from the pelvis minor, across the right external iliac vessels and the corresponding psoas major muscle, to join the cæcum at the level of the intersection of the intertubercular and right lateral planes. To bring it into view lift the lower coils of the ileum from the pelvis minor and pull them towards the left side.

The coils formed by the jejunum and ileum are suspended from the posterior wall of the abdomen by a wide fold of peritoneum, called *the mesentery.* They are thus, for the main part, freely movable within the cavity. Owing to the manner in which the mesentery is attached to the posterior wall of the abdomen (Fig. 138, p. 294), they tend to lie more in the left than in the right portion of the cavity, and they occupy the umbilical, hypogastric, lumbar, and iliac regions, filling up the greater part of the abdominal cavity below the transverse colon and its mesentery. Some of the coils extend downwards into the pelvis minor, and not uncommonly one or more coils of the jejunum may be found in the left hypochondrium.

Meckel's Diverticulum.—In about 2 per cent. of subjects dissected a blind, hollow protrusion, termed Meckel's diverticulum, juts out at a right angle from the wall of the ileum, at a point rather less than three feet from the junction of the small intestine with the cæcum. It represents a persistent portion of the vitelline duct of the embryo, and under certain circumstances it may lead to conditions which require surgical interference.

The Mesentery of the Small Intestine.—The mesentery of the small intestine is an extensive fold of peritoneum by which the jejunum and ileum are attached to and suspended from the posterior wall of the abdomen. Its posterior border or *root* is attached along an oblique line which extends, from above downwards and to the right, from the left side of the second lumbar vertebra to the right iliac fossa, crossing in its course the third part of the duodenum, the abdominal aorta, the inferior vena cava, the right ureter, and the right psoas major muscle. This border is about six inches long. The anterior border of the mesentery is attached to the intestine, and is necessarily as long as the part of the gut to which it is attached, that is, about twenty-two feet; but this great length is not at first apparent because the mesentery is thrown into folds like a frill (Fig. 145) and the coiled condition of the gut is due to that arrangement. Thus, the mesentery is markedly fan-like, and its length, from its root to its intestinal attachment, at its longest part, is about 15 cm. (six inches) after death and when the body is hardened, but it may be considerably longer during life.

The two layers of the peritoneum of the mesentery are not in apposition. They are separated by a variable amount of fat and areolar tissue in which lie the superior mesenteric artery and its branches to the jejunum and ileum, the corresponding veins, the accompanying nerves, the lymph vessels, called *lacteals*, passing from the gut, and numerous lymph glands. The jejunum and ileum lie in the free anterior border of the fold.

The amount of fat between the two layers of the mesentery varies, not only in different subjects but also in different parts of the mesentery. The amount is greatest near the root of the mesentery and smallest near the gut. The difference referred to is most marked in the upper part of the mesentery, near the duodena-jejunal flexure, where the amount of fat is so small that semi-translucent areas or *peritoneal windows* are recognisable between the loops of anastomoses formed by the jejunal branches of the superior mesenteric artery; near the lower part of the ileum, where the fat is more abundant, the "windows" cannot be seen. The difference is taken advantage of by the operating surgeon who wishes to know whether he is dealing with an upper or a lower coil of the small intestine.

Occasional Peritoneal Fossæ.—Before the dissection of the mesentery is commenced the dissector should look for certain peritoneal fossæ which are occasionally present. Some of the fossæ lie near the terminal part of the duodenum, others near the termination of the ileum, and one is associated with the root of the pelvic meso-colon.

The chief fossæ in the region of the duodenum are the *duodeno-jejunal*, the *superior duodenal*, the *inferior duodenal*, the *para-duodenal*, and the *retro-duodenal*.

The *duodeno-jejunal* or meso-colic *fossa* lies immediately above the duodeno-jejunal flexure of the small intestine and passes upwards into the root of the transverse meso-colon. The *superior* and the *inferior duodenal fossæ* lie at the left side of the terminal portion of the duodenum, the upper passing upwards and the lower passing downwards. The *para-duodenal fossa* lies a little more to the left. It is a pouch of peritoneum pushed laterally behind the inferior mesenteric vein, and its mouth looks towards the terminal part of the duodenum. The *retro-duodenal fossa* passes upwards behind the terminal part of the duodenum.

The fossæ in the region of the ileo-cæcal junction are the *anterior ileo-cæcal*, the *posterior ileo-cæcal*, and the *retro-cæcal* or retro-colic. The anterior ileo-cæcal fossa lies behind a small fold of peritoneum which crosses the front of the ileo-cæcal junction. Its mouth is directed downwards and to the left. The inferior ileo-cæcal fossa also opens towards the left. It is bounded to the right by the cæcum, in front by the terminal part of the ileum and the adjacent part its mesentery, behind by the mesentery of the vermiform process, and below by the *plica ileo-cæcalis*, a fold of peritoneum which passes from the lower border of the ileum to the anterior surface of the mesentery of the vermiform process or, sometimes, to the process itself. The *retro-cæcal* or retro-colic fossa passes upwards behind the upper part of the cæcum and the lower part of the ascending colon; when this fossa is present the vermiform process usually lies in it.

The *inter-sigmoid fossa* also should be looked for at this stage, in order that, if it is present, its boundaries may be examined before they are interfered with by dissection. It runs upwards behind the root of the pelvic meso-colon, at the left side of the last lumbar vertebra. To find it, turn the pelvic part of the colon upwards.

Dissection.—After the occasional peritoneal fossæ which happen to be present have been examined make an incision through the peritoneum of the right side of the root of the mesentery, from its upper to its lower end, and reflect the right layer of the mesentery towards the gut from above downwards. As the reflection proceeds take away the fat which lies between the two layers and clean the structures which are exposed. They are—(1) the trunk of the superior mesenteric artery surrounded by the superior mesenteric plexus of nerves, lying along the root of the mesentery; (2) the superior mesenteric vein, which lies usually to the right of the artery; (3) the intestinal branches of the superior mesenteric artery, passing to the wall of the gut; (4) the accompanying veins, nerves, and lymph vessels; and (5) the mesenteric lymph glands, which lie in the intervals between the blood-vessels; they are scattered at varying distances from the border of the gut to the superior mesenteric trunk in the root of the mesentery.

After the structures which lie between the two layers of the mesentery have been cleaned make an incision through the peritoneum on the posterior wall of the abdomen from the upper end of the root of the mesentery to the upper end of the ascending colon, then reflect the peritoneum, below the level of the incision, downwards and to the right to the medial margin of the ascending colon and the ileo-cæcal junction. Now clear away the extra-peritoneal fat which is displayed, and expose the structures which lie on the posterior wall of the abdomen between the root of the mesentery and the ascending colon. Most superficially, immediately behind the peritoneum, will be found the right colic and ileo-colic branches of the superior mesenteric artery, with the accompanying veins, nerves, lymph vessels and glands. In the upper part of the region, directly below the root of the transverse meso-colon, the lower part of the descending portion and the right part of the inferior portion of the duodenum will be found, with the superior mesenteric artery and vein, crossing in front of the inferior portion. Behind

PLATE XV

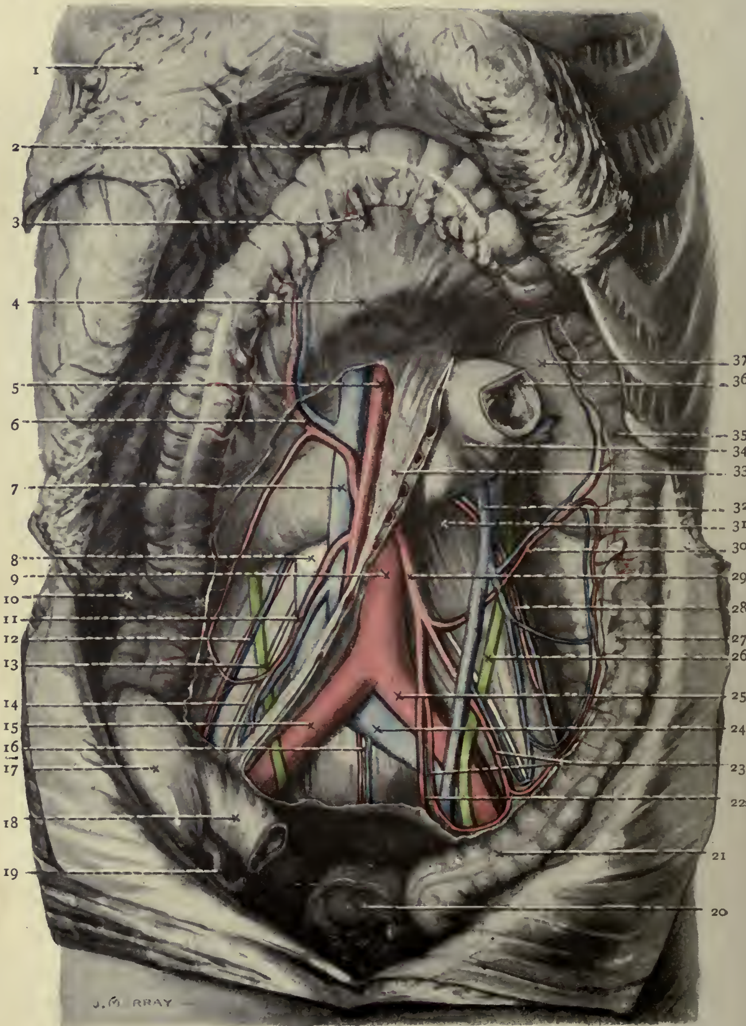


FIG. 146.

PLATE XV

FIG. 146.—Dissection of the lower part of the Abdomen.

The greater omentum and the transverse colon have been turned upwards.

The small intestine has been removed, and the peritoneum and extra-peritoneal fat have been dissected away from the structures on the posterior wall of the abdomen below the level of the transverse meso-colon.

1. Greater omentum.
2. Transverse colon.
3. Appendices epiploicæ.
4. Transverse meso-colon.
5. Superior mesenteric artery.
6. Middle colic artery.
7. Superior mesenteric vein.
8. Inferior vena cava.
9. Aorta.
10. Right flexure of the colon.
11. Common trunk of right and ileo-colic arteries.
12. Internal spermatic vessels.
13. Ureter.
14. Genito-femoral nerve.
15. Right common iliac artery.
16. Middle sacral vessels.
17. Cæcum.
18. Ileum.
19. Vermiform process.
20. Pelvic colon.
21. Iliac colon.
22. Superior hæmorrhoidal artery.
23. Sigmoid arteries.
24. Left common iliac vein.
25. Left common iliac artery.
26. Ureter.
27. Descending colon.
28. Internal spermatic vessels.
29. Inferior mesenteric artery.
30. Left colic artery.
31. Psoas major muscle.
32. Inferior mesenteric vein.
33. Mesentery of small intestine (cut).
34. Duodeno-jejunal flexure.
35. Left flexure of the colon.
36. Jejunum.
37. Left kidney.

the superior mesenteric artery, at a lower level, is a part of the aorta, and to the right of the aorta is the inferior vena cava. Partly behind the duodenum and partly to the right of it, on a posterior plane, is the lower pole of the right kidney. The right ureter emerges from behind the duodenum and passes downwards on its way to the brim of the pelvis minor along the medial border of the lower pole of the kidney, and then behind the ileo-colic and the superior mesenteric arteries. The internal sper-

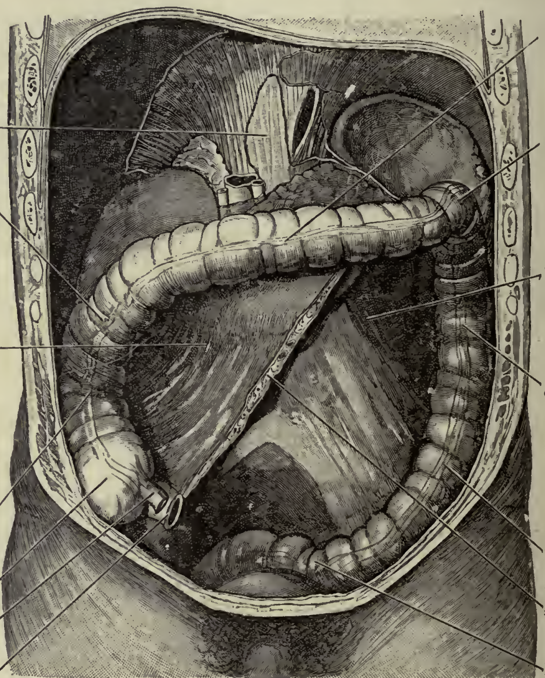


FIG. 147.—Abdomen after removal of Liver, Stomach, Jejunum and Ileum.

matic vessels cross in front of the ureter (Fig. 146), and the genito-femoral nerve passes downwards and laterally, behind the ureter, on the anterior surface of the psoas major muscle. Beyond the lateral border of the psoas major the fascia on the anterior surface of the quadratus lumborum will be exposed.

When the structures mentioned have been cleaned make an incision through the lower layer of the transverse meso-colon, from the upper end of the root of the mesentery to the transverse colon; then reflect the part of the lower layer of the transverse meso-colon which lies to the right of the incision towards the transverse colon. As the reflection proceeds the trunk and branches of the middle colic artery and the accompanying veins, nerves, lymph vessels and lymph glands will be exposed, and the anastomoses of the branches of the middle colic artery with branches of the right colic artery will be displayed.

After the structures in the right part of the transverse meso-colon have been secured and cleaned throw the small intestine over to the right side and make two incisions through the peritoneum on the left part of the posterior wall of the abdomen; one, a transverse incision, from the upper end of the root of the mesentery to the upper end of the descending colon, and the other along the left side of the root of the mesentery from its upper to its lower end. After the incisions have been made reflect the left half of the lower layer of the transverse meso-colon towards the transverse colon and display the anastomoses of the left branches of the middle colic artery with the upper branches of the left colic artery, and the associated veins, lymph vessels, lymph glands and nerves. When those structures have been cleaned reflect the peritoneum on the left part of the posterior wall of the abdomen downwards and to the left. When the reflection is completed and the extra-peritoneal fat has been removed the dissector will find that he has exposed a greater number of structures than he did when he removed the peritoneum covering the posterior wall of the abdomen to the right of the root of the mesentery. In the median plane, below the root of the mesentery, lies the lower part of the abdominal portion of the aorta, dividing, opposite the fourth lumbar vertebra, into the two common iliac arteries, each of which is continued downwards into the corresponding external iliac artery. On the surface of the aorta is the aortic plexus of nerves, which must be carefully preserved. To the right of the aorta is the lower part of the inferior vena cava, and to the right of and below the left common iliac artery is the left common iliac vein. Springing from the front of the aorta, about one and a half inches above its bifurcation and to the left of the median plane, is the inferior mesenteric artery. The inferior mesenteric artery runs downwards on the left of the aorta to the left common iliac artery, where it becomes the superior hæmorrhoidal artery. Before it becomes the superior hæmorrhoidal it gives off the left colic branch, and two or more sigmoid branches. The left colic branch passes to the left, towards the descending colon, and divides into an ascending and a descending branch, which run towards the upper and the lower parts of the descending colon respectively. The sigmoid branches run downwards and laterally towards the lower part of the iliac colon. To the left of the inferior mesenteric artery is the inferior mesenteric vein, which ascends to the root of the transverse meso-colon. As it ascends it crosses behind the left colic artery and in front of the internal spermatic vessels; when it reaches the root of the transverse meso-colon it disappears behind the lower border of the pancreas, which is exposed in the upper part of the area under consideration. To the left of the lower part of the inferior mesenteric vein are the internal spermatic vessels, which pass behind the sigmoid and left colic arteries, or their branches, and then behind the inferior mesenteric vein; they also disappear above behind the pancreas. In the upper and left angle of the area, in the concavity of the left flexure of the colon, is the lower part of the left kidney, and, descending along its medial border, the left ureter, which passes downwards, behind the internal spermatic vessels and the left colic and sigmoid arteries, to the lower end of the left common iliac artery. Running downwards and laterally behind the left ureter, on the front of the left psoas major muscle, is the left genito-femoral nerve, and beyond the lateral border of the left psoas is the fascia on the front of the medial part of the left quadratus lumborum. Along the anterior border of the psoas, at the left of the aorta, is the left sympathetic trunk. The right sympathetic trunk is concealed by the inferior vena cava.

When the dissector has found and defined all the structures mentioned, he should commence the study of the superior and the inferior mesenteric arteries and their branches. He will find that the superior mesenteric supplies the terminal portions of the duodenum, the whole of the jejunum and the ileum, the cæcum, the ascending colon and the greater part of the transverse colon; that the inferior mesenteric supplies the left part of the transverse colon, the left flexure of the colon, the descending colon, the iliac colon, and the pelvic colon, and that it furnishes also the greater part of the blood supply of the rectum, by means of its continuation—the superior hæmorrhoidal artery. He will find also that there is a very free anastomosis between the left colic branch of the inferior mesenteric artery and the middle colic branch of the superior mesenteric artery. At a later period he will find that an inferior pancreatico-duodenal branch of the superior mesenteric artery anastomoses with the superior pancreatico-duodenal branch of the gastro-duodenal artery, and when he recalls to mind the fact that the gastro-duodenal artery is a branch of the hepatic, and that it furnishes the right gastro-epiploic, which passes to the stomach and anastomoses on its surfaces with the other arteries which supply that viscus, he will recognise that a complete chain of arterial anastomoses runs along the wall of the abdominal part of the alimentary canal, providing for the continuance of the blood supply to the wall of the gut in the event of one or more of the bigger trunks being temporarily or permanently occluded.

Arteria Mesenterica Superior.—The superior mesenteric artery springs from the front of the abdominal aorta about 6.5 mm. (quarter of an inch) below the cœliac artery. At its origin it is covered by the neck of the pancreas, and it is crossed by the splenic vein. After it emerges from under cover of the neck of the pancreas, it proceeds downwards, in front of the lower portion of the head of the pancreas; then it crosses the inferior part of the duodenum, to the right of the duodeno-jejunal flexure, and enters the root of the mesentery proper, along which it proceeds to the right iliac fossa, where it ends by anastomosing with one of its own branches. Between its extremities it is slightly curved, the convexity of the curve being directed to the left. It is accompanied by the superior mesenteric vein, which lies upon its right side, and by the superior mesenteric plexus of nerves, which surrounds it.

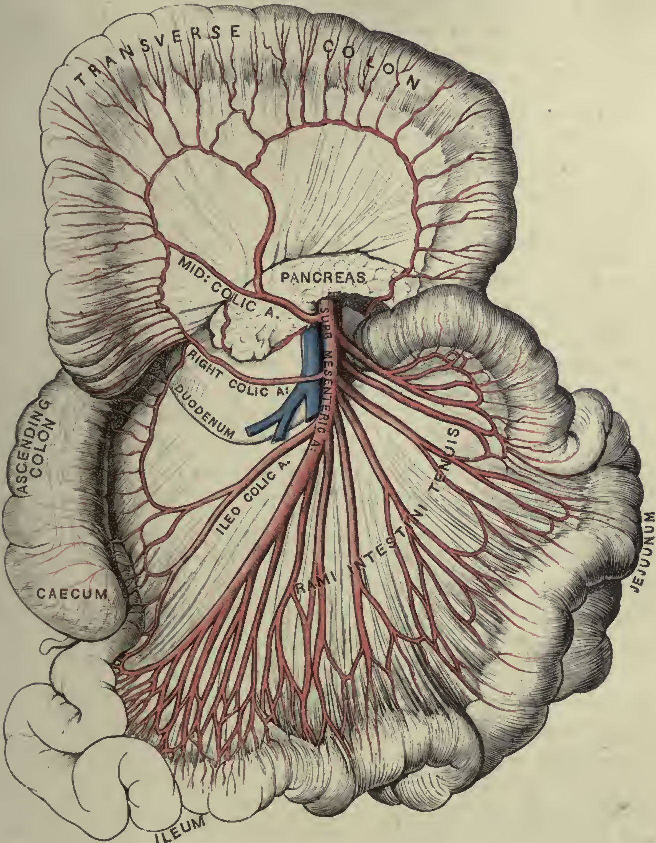


FIG. 148.—Dissection of the Superior Mesenteric Artery.

It gives off the following branches :—

<table>
<tr><td rowspan="6">Aa. Intestinales</td><td colspan="2">A. pancreatico-duodenalis inferior.</td></tr>
<tr><td>Aa. jejunales</td><td rowspan="2">to jejunum and ileum.</td></tr>
<tr><td>Aa. ileæ</td></tr>
<tr><td>A. ileocolica</td><td rowspan="3">to large intestine.</td></tr>
<tr><td>A. colica dextra</td></tr>
<tr><td>A. colica media</td></tr>
</table>

Arteria Pancreatico-duodenalis Inferior.—The inferior pancreatico-duodenal branch takes origin from the upper part of the superior mesenteric artery, or from its first intestinal branch, and passes upwards and to the right behind the head of the pancreas. It gives branches both to the duodenum and to the pancreas, and anastomoses with the superior pancreatico-duodenal artery.

Arteriæ Jejunales et Ileæ.—The jejunal and ileal branches spring from the convexity or left side of the superior mesenteric, and proceed obliquely downwards and to the left, between the layers of the mesentery, to supply the jejunum and ileum. They are very numerous—from twelve to fifteen, or even more, in number—and, by the inosculations of their branches, they form a very remarkable succession of arches between the layers of the mesentery. At first they run parallel to one another; but soon each divides into two branches which join the immediately adjacent branches of the neighbouring stems, and in that way a series of *arterial arcades* is formed. From the primary arcades smaller vessels proceed, which divide and unite, in a similar manner, to form a second series of arches; and so on, until three, four, or perhaps even five, tiers of arterial arcades are produced. From the most peripheral arches numerous small branches pass directly to the wall of the intestine. At the intestine, along the line of mesenteric attachment, they divide, and the minute twigs, thus derived, pass transversely round the gut so as to encircle it. At first they lie immediately subjacent to the peritoneal coat of the bowel, but soon they seek a deeper plane in the wall of the intestine, and ultimately after passing through the muscular coats their terminal branches reach the submucous coat. The number of arterial arcades which intervene between the primary and terminal branches increases towards the lower part of the small intestine (Fig. 148).

Arteria Ileocolica.—The ileo-colic artery springs from the middle of the concavity of the superior mesenteric, and proceeds downwards and laterally towards the right iliac fossa. It is placed behind the parietal peritoneum, and divides into an ascending and a descending or ileo-cæcal branch. The *ascending branch* turns upwards, inosculates with a branch of the right colic, and from the arterial arch thus formed branches are given to the ascending colon. The *descending branch*, sometimes called the *ileo-cæcal artery*, proceeds to the upper part of the ileo-cæcal junction and sends branches in different directions. Two, termed the *anterior* and *posterior cæcal arteries*, pass respectively to the front and back of the cæcum; one, a slender vessel, the *artery to the vermiform process*, runs downwards behind the terminal part of the ileum and supplies the vermiform process, which it reaches by passing between the layers of the mesentery of that process; a fourth, the *ileal artery*, turns to the left along the ileum, it forms a loop with the termination of the superior mesenteric trunk.

Arteria Colica Dextra.—The right colic artery arises together with, or above, the ileo-colic, and passes to the right, behind the parietal peritoneum on the posterior wall of the abdomen. It divides into two branches, a superior and an inferior. The *superior branch* ascends, and at the right colic flexure it passes between the two layers of the transverse meso-colon to inosculate with the middle colic; whilst the *inferior branch* joins the ascending branch of the ileo-colic artery. From the convexity of the arches twigs proceed to the ascending colon, the right flexure of the colon, and part of the transverse colon.

Arteria Colica Media.—The middle colic artery springs from the upper part of the superior mesenteric. It passes, at once, between the two layers of the transverse meso-colon, and divides into a right and a left branch. The *right branch* joins the superior part of the right colic, whilst the *left branch* inosculates with the ascending part of the *left colic artery*, which is derived from the inferior mesenteric. Arterial arcades are thus formed in the transverse meso-colon, from which branches proceed for the supply of the transverse colon. Some of the branches pass beyond the transverse colon and descend between the two posterior layers of the great omentum.

Vena Mesenterica Superior.—The superior mesenteric vein is a large vessel which lies to the right of the superior mesenteric artery. It receives tributaries from those parts of the intestinal canal supplied by branches from the superior mesenteric artery; it also receives the right gastro-epiploic vein, from the greater curvature of the stomach, and the pancreatico-duodenal vein. It passes upwards, in front of the inferior part of the duodenum, and, leaving the root of the mesentery, disappears behind the neck of the pancreas, where it unites with the splenic vein to form the *vena portæ*.

Plexus Mesentericus Superior.—The superior mesenteric plexus is a dense plexus of sympathetic nerve twigs which surrounds the superior mesenteric artery like a sheath. From it filaments are prolonged to the intestine along the various branches of the artery. As the nerves approach the bowel, some of the twigs leave the vessels and effect a series of communications with each other in the intervals between the arteries.

The superior mesenteric plexus is an offshoot from the *cœliac plexus*, and it distributes twigs to the jejunum and ileum, and to the right half of the large intestine.

Lymphoglandulæ Mesentericæ.—The mesenteric lymph glands are very numerous—indeed, considerably over a hundred in number. They lie between the layers of the mesentery and, in health, they rarely attain a size greater than that of a small bean, whilst they may be as small as a pin head. They form three main groups. First, a series of juxta-intestinal glands, situated near the gut; next, an intermediate group, associated with the larger branches of the jejunal and ileal arteries; and thirdly, a group of large glands placed close to the trunk of the superior mesenteric artery.

The *lacteals*, which are the lymph vessels of the intestine, issue from the wall of the gut in enormous numbers. They also form a series of relays. First, those which pass from the intestine to the juxta-intestinal glands; secondly, those which connect the various glands together; and finally, a group of efferent vessels, from the largest glands, which fuse together to form a *common intestinal trunk*. The common intestinal trunk terminates in the cisterna chyli, which will be displayed in a later dissection.

Lymph glands are also found on the walls of the large intestine, along its concave border, and in association with the branches of the arteries which supply it. The lymph from the cæcum, the vermiform process, the ascending colon, and the transverse colon passes to the common intestinal trunk, through lymph vessels which accompany the arteries of supply to the parts named, and so to the cisterna chyli. The lymph from the descending colon, the iliac colon, and the pelvic colon passes along vessels and through the lymph glands associated with the branches and the trunk of the inferior mesenteric artery, and thence to the lumbar glands, whence it is conveyed to the cisterna chyli.

Arteria Mesenterica Inferior.—The inferior mesenteric artery, considerably smaller than the superior mesenteric, springs from the left side of the front of the abdominal aorta, about 37·5 mm. (an inch and a half) above its termination. It descends, with a slight inclination to the left, to the brim of the pelvis minor, where it crosses the left common iliac

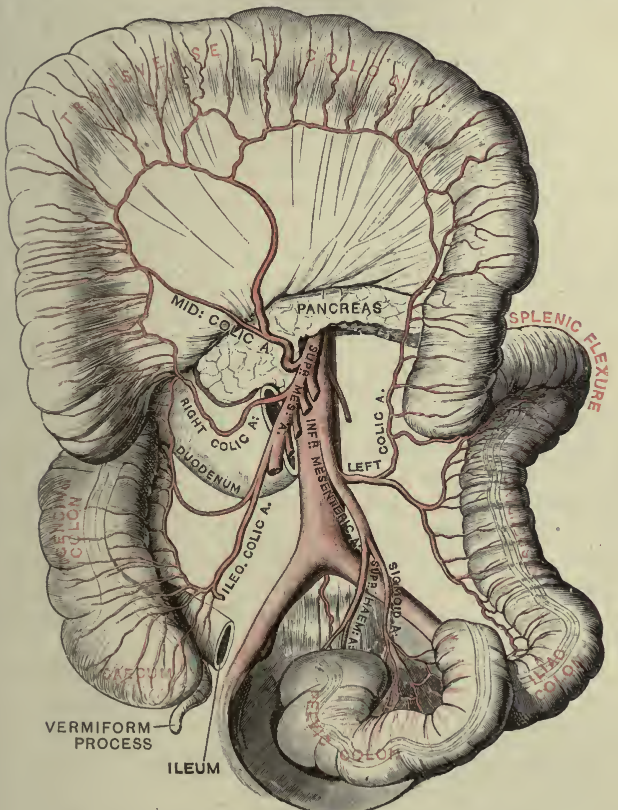


FIG. 149.—Dissection of the Inferior Mesenteric Artery

artery and becomes the *superior hæmorrhoidal artery*, which descends into the pelvis minor. Before the inferior mesenteric artery reaches the left common iliac artery it gives off the left colic and the sigmoid branches.

Arteria Colica Sinistra.—The left colic artery runs to the left and divides into two branches, of which one ascends, in front of the lower part of the left kidney, to the trans verse meso-colon, where it inosculates with the middle colic artery. The other descends, behind the peritoneum of the posterior wall of the abdomen, to unite with the superior sigmoid artery. From the arches thus formed twigs are supplied to the transverse colon, the left flexure of the colon, and the descending colon. The point of division into upper and lower branches is very variable.

Arteriæ Sigmoideæ.—The sigmoid arteries, one to three in number, are distributed to the lower part of the descending colon, the iliac colon, and the pelvic colon. The highest branch enters the left iliac fossa, behind the parietal peritoneum. It sends a branch upwards to form an arch with the descending branch of the left colic, and another downwards, which ultimately enters the pelvic meso-colon and joins the other sigmoid branches. The lower sigmoid arteries pass into the pelvic meso-colon, and there form a series of arcades, varying in number according to the length of that mesentery; from those arcades the twigs for the supply of the pelvic colon are given off.

The *superior hæmorrhoidal artery* will be followed out in the dissection of the pelvis minor.

Vena Mesenterica Inferior.—The inferior mesenteric vein receives tributaries corresponding with the branches of the inferior mesenteric artery. It passes upwards, upon the psoas major muscle, under cover of the peritoneum, to the left of, and at some distance from, the artery, and, after disappearing behind the pancreas, it ends in the splenic vein.

Plexus Mesentericus Inferior.—The *inferior mesenteric plexus of nerve fibres* is an offshoot from the left side of the aortic plexus. It closely surrounds the artery, and sends twigs along the branches of the vessel to supply the left half of the large intestine.

Plexus Aorticus Abdominalis.—The abdominal aortic nerve plexus is placed upon the aorta, between the origins of the two mesenteric arteries. It is more strongly marked upon the sides of the artery than in front of it. Its continuity, above, with the cœliac and renal plexuses, will be demonstrated at a later stage of the dissection. From its lower extremity several large branches descend, in front of the common iliac arteries, to join the hypogastric plexus—a plexus which is situated in front of the fifth lumbar vertebra. Upon each side the aortic plexus is reinforced by several small twigs from the gangliated trunk of the sympathetic. The *inferior mesenteric plexus*, accompanying the artery of that name, and the *internal spermatic* (or *ovarian*) *plexus* of nerves, which accompanies the internal spermatic (or *ovarian*) artery, are offsets from the aortic plexus.

***Dissection.*—Removal of the Jejunum and Ileum.**—Apply two ligatures round the jejunum about an inch below the duodeno-jejunal flexure, and divide the gut between them; next, place two ligatures round the ileum, about six inches from its union with the large intestine, and divide it in like manner; then cut through the blood-vessels and the remains of the mesentery close to the wall of the gut, and remove the separated portion. Take the detached portion of the gut to the sink, cut away the ligatures, and clean the cavity of the gut by allowing water from the tap to run through it.

The coats of the small intestine must be dissected under water. Take a few inches from the upper end of the jejunum, and, having opened it up with the scissors along the line of mesenteric attachment, pin it out, with its mucous surface downwards, upon the bottom of a cork-lined tray which has been previously filled with clean water. The jejunum is chosen because its wall is thicker than that of the ileum, and consequently is more easily dissected. Carefully remove the thin serous coat, in order that the subjacent layer of longitudinal muscular fibres may be studied. Then turn the specimen round and pin it down with its mucous surface uppermost. Now remove the mucous membrane and the subjacent flocculent submucous coat, with the scissors, in one layer. The circular muscular fasciculi will then come into view.

Structure of the Small Intestine.—The wall of the small intestine is composed of five coats or strata, viz.:—

1. Serous.
2. Subserous.
3. Muscular.
4. Submucous.
5. Mucous.

The *serous coat* of the jejunum and ileum is complete, except along the line of the mesenteric attachment. It is exceedingly thin—much thinner than the layers of the mesentery with which it is continuous. Unless great care is taken in stripping it off, some of the subjacent muscular fibres will be taken away with it. The *subserous coat* is a scarcely appreciable amount of areolar tissue which intervenes between the peritoneum and the muscular coat and connects them together. The *muscular coat* is composed of involuntary, non-striated muscular fibres, which are disposed in two layers, viz., an *external stratum* of longitudinal fibres, and an *internal stratum* of circular fibres. The circular layer is the thicker and more distinct of the two. The external longitudinal fibres are spread out, in the form of a thin continuous layer, all round the circumference of the intestine, but the layer is thickest in that part of the wall which is furthest from the mesenteric attachment. The *submucous coat* is composed of loose areolar tissue which binds the muscular to the mucous coat. It is more firmly connected with the latter than the former. The *mucous coat* must be examined throughout the whole length of the jejunum and ileum.

FIG. 150.—Typical part of Jejunum, showing numerous and large Plicæ Circulares.

Dissection.—It has already been noted that little distinction can be drawn between the upper and lower parts of the small intestine from their external appearances, beyond the fact that as the intestine descends it diminishes slightly in calibre and its walls diminish in thickness (cp. p. 273). The internal appearances of the upper part of the jejunum and the lower part of the ileum, on the other hand, are very different, and the small intestine must now be opened in order that the internal difference may be investigated. In the first place, however, remove about 30 cm. (twelve inches) of the upper part of the jejunum; ligature it at both ends and distend it with air by means of a blow-pipe; then hang it up to dry, in order that the folds of the mucous membrane, called *plicæ circulares*, may be investigated in their entirety. The best way to open the remainder of the small intestine is to tie a ligature round the lower cut end of the ileum and then fill the gut as full as possible with water. When that has been done take the scissors and impale a small piece of costal cartilage on the point of one blade. Introduce the blade, so protected, into the gut and run the scissors downwards along the line of the attachment of the mesentery. If the procedure described is followed the gut will easily be laid open from end to end.

Mucous Membrane of the Small Intestine.—The *plicæ circulares* (O.T. *valvulæ conniventes*) are the most conspicuous objects on the inner wall of the small intestine. They are folds of the mucous membrane placed more or less transversely to the long axis of the intestine. Note particularly that they are *permanent folds*, and that no amount of stretching or distension of the walls will cause their obliteration. On careful study of the dried specimen three main varieties of plicæ circulares may be recognised. The great majority are in the form of crescentic folds, which extend for a variable distance round the wall of the intestine; others form complete rings around the interior; the third variety, usually the least numerous, are arranged in a spiral manner, and take from one to three spiral turns around the wall of the intestine. Each fold consists of two layers of mucous membrane, with a little intervening areolar tissue derived from the submucous coat. The other coats of the intestine take no part in the formation of the plicæ circulares. In the upper part of the jejunum the plicæ circulares are strongly developed, and placed so closely together that the intervals between them are hardly greater than the thickness of one of the folds. Lower down, however, the plicæ gradually diminish in numbers, become more widely separated, more oblique in their direction, and not nearly so large. Towards the middle of the ileum, they become few and far between, and a little beyond that point they usually disappear altogether (Figs. 150, 151).

FIG. 151. — Typical part of Ileum, showing few and small Plicæ Circulares.

The chief function of the plicæ circulares is to increase the absorbing and secreting surface of the small intestine.

Another characteristic of the mucous lining of the small intestine is the presence of *villi*. They are minute projections of the mucous membrane, varying in length from about .8 to .6 mm. ($\frac{1}{30}$th to $\frac{1}{40}$th of an inch). They occur in enormous numbers over the entire extent of the inner surface of the intestine, not only upon the plicæ circulares, but also in the intervals between them, and they give to the mucous membrane a velvety or fleecy appearance.

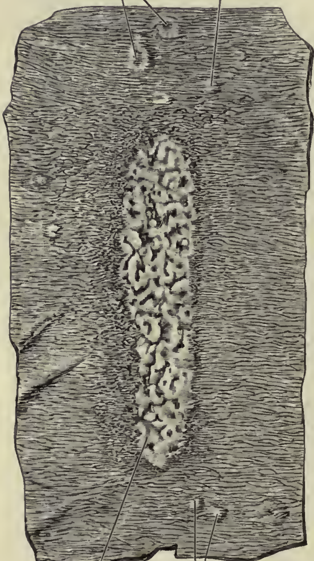


FIG. 152.—Aggregated Lymph Nodule and Solitary Lymph Nodules from the intestine of a child of two years old. (Birmingham.)

To obtain a proper view of the villi float out a portion of the small intestine in water, after it has been carefully cleansed from adhering mucus, and examine it with an ordinary pocket-lens. If a portion of the upper end of the jejunum is placed side by side with a portion of the lower part of the ileum, and the two are contrasted, the student will readily detect that the villi are, if anything, larger and decidedly more numerous in the jejunum than in the ileum. They diminish gradually in number and in size from above downwards.

Noduli lymphatici aggregati et noduli lymphatici solitarii.—Aggregated lymph nodules (O.T. *Peyer's patches*) and solitary lymph nodules must also be looked for. Frequently they are difficult to find, but if the bowel is held up to the light they can generally be detected. When seeking aggregated lymph nodules it is best to examine the ileum from below upwards.

An *aggregated lymph nodule* consists of a large number of lymph follicles grouped together so as to present to the eye a patch of an elongated, oblong outline. The nodules are placed upon that aspect of the intestine which is opposite to the line of the mesenteric attachment, and the long axis of each corresponds in its direction with that of the intestine itself.

In the lower part of the ileum the aggregated nodules may be from 25 mm. to 100 mm. (1 to 4 inches) long, and 12.5 mm. (half an inch) broad, but higher in the ileum they become much smaller and not nearly so numerous, and they are either few in number, or entirely absent, in the jejunum. The total number varies much, but the average number may be stated to be about thirty. They are more numerous in the young, and not so abundant nor so distinctly marked out in later periods of life. Indeed, in very old subjects they may disappear almost entirely.

The *solitary lymph nodules* are isolated lymph follicles, scattered everywhere in the mucous membrane of the small intestine. They are minute, rounded or ovoid, opaque white bodies, about the size of a millet seed, and they usually cause a slight bulging of the mucous membrane at the points where they occur.

The *plicæ circulares*, the *villi*, and *aggregated lymph nodules* are the only special peculiarities of the mucous membrane of the jejunum and ileum which are visible to the naked eye; and, from what has been said regarding them, the dissector will understand that, although they are not arranged in such a way as to mark off the jejunum from the ileum by a clear line of demarcation, they are sufficient to enable him to distinguish between characteristic portions of each—*i.e.* between portions taken at some distance from the arbitrary line of division. The following are the essential points of difference which should guide him in deciding which is ileum and which jejunum:—

Jejunum.	Ileum.
Plicæ Circulares.	
Numerous and well marked.	Few in number and poorly developed, and, in its lower part, absent altogether.
Villi.	
Numerous and large.	Not so numerous and not so large.
Aggregated Lymph Nodules.	
Few in number, small in size, and, as a rule, nearly circular in outline.	More numerous, of large size, and oblong in form.

The general position and the constituent portions of the large intestine have already been noted (p. 274); the positions and relations of the individual parts must now be studied more completely.

Intestinum Crassum.—The total length of the large intestine varies from 134 to 167 cm. (4½ to 5½ feet). The cæcum, which is the shortest segment, is 64 mm. (2¾ inches) long, and as broad, or broader, than it is long. The ascending colon is from 12.5 cm. to 20 cm. long (5 to 8 inches). The transverse colon, which is the longest segment, is from 47.5 to 50 cm. in length (19 to 20 inches). The descending colon is somewhat shorter than the ascending colon, varying from 10 to 15 cm. (4 to 6 inches) in length. The iliac colon varies from 12.5 to 15 cm. (5 to 6 inches) in length; it is, therefore, slightly longer than the descending colon. The length of the pelvic colon varies very considerably, but averages from 40 to 42.5 cm. (16 to 17 inches). The rectum is the same length as the iliac colon, 12.5 to 15 cm. (5 to 6 inches). The pars analis recti, or anal canal, which forms the terminal segment of the large intestine, is from 25 mm. to 37.5 mm. (1 to 1½ inches) long. The measurements given are those which have been estimated on formol-hardened bodies, in which the walls of the intestines are more or less contracted; they are, therefore, minimal measurements, and the lengths of the various segments will be found to be greater in unhardened bodies, such as those met with in the post-mortem room.

The walls of all parts of the large intestine, except the anal canal, are sacculated, but the sacculations vary in size and number in the different segments, being largest and least numerous in the rectum. During life, and after death, the descending colon, the iliac colon, and the anal canal are usually empty and their walls are contracted; but the walls of the other portions of the large gut are usually flaccid, even when they are not distended.

Intestinum Cæcum.—The cæcum is the first section of the large gut. It has the appearance of a sacculated pouch, 65 to 70 mm. (2 or 3 inches) long. Its width varies, but is rarely less than its length, and it may be a little greater. It is continuous, above, with the ascending colon, and on the left, with the ileum, and with the vermiform process, which, in the adult, is a diverticulum from the cæcum. It is completely clothed with peritoneum, and is supplied with blood by branches derived from the loop between the termination of the superior mesenteric artery and its ileo-colic branch.

Processus Vermiformis (O.T. **Vermiform Appendix**).—The vermiform process springs from the medial and posterior aspect of the cæcum, about 25 mm. (1 inch) below the ileo-cæcal junction. It passes either upwards and to the left, towards the left hypochondrium, or downwards into the pelvis minor, across the right external iliac artery, or upwards behind

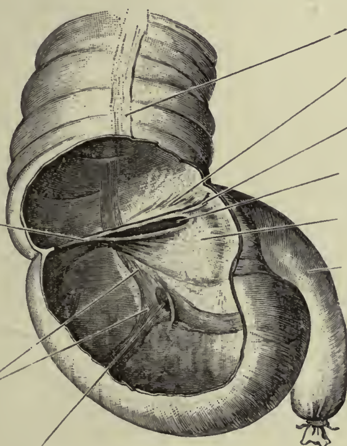


FIG. 153.—Cæcum which has been distended with air and dried, and then opened to show Ileo-Cæcal Opening and Colic Valve. (Birmingham.)

the cæcum and the ascending colon. It usually occupies the last position if a retro-colic pouch is present. It is attached, by the *mesentery of the vermiform process*, to the posterior surface of the lower part of the mesentery of the ileum.

Dissection.—Turn the cæcum upwards; remove the peritoneum from the wall of the iliac fossa behind it, and take away the extra-peritoneal fat. Note that the peritoneum and fat separate the cæcum from the right psoas and iliacus muscles, and from the femoral nerve (O.T. anterior crural) which lies in the angle between the muscles. The anterior surface of the cæcum is in relation with the anterior wall of the abdomen, or is separated from it by the lower part of the greater omentum.

Cut away a portion of the right lateral wall of the cæcum and examine the ileo-cæcal orifice and the orifice of the vermiform process from the interior of the intestine.

The Ileo-Cæcal Orifice is an antero-posterior slit, bounded by two protruding lips, a superior and an inferior, which are formed by the partial invagination of the lower end of the ileum into the cæcum. The two lips are the two segments of the *valve of the colon* (O.T. *ileo-cæcal valve*). At the extremities of the orifice the segments of the valve unite together and become continuous with a ridge of the wall of the gut which is prolonged around the cavity. The anterior and posterior parts of the ridge, immediately adjacent to and connected with the lips of the valves, are spoken of as the *frenula of the valve*.

The peritoneum and the longitudinal muscular bands are

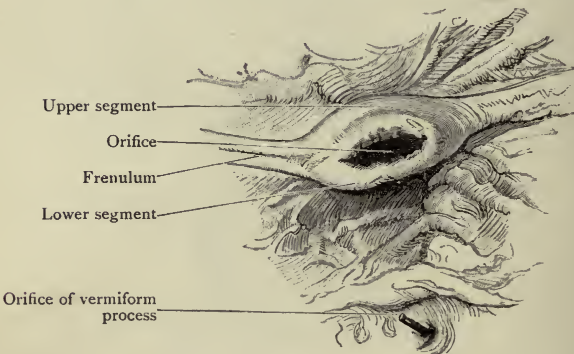


FIG. 154.—Ileo-Cæcal Opening and Valve of the Colon from a subject hardened by formalin injection. (Birmingham.)

in no way involved in the infoldings which form the valve-flaps; but some of the other constituents of the gut-wall (viz., the mucous membrane, the submucous coat, and the circular muscular fibres) take part in their formation. Villi are present on the ileal but not on the cæcal aspect of each valve-flap.

The function of the valve is obvious. It is so arranged that the free passage of materials from the ileum into the cæcum is in no way impeded; but when the cæcum becomes distended, and there is, consequently, a tendency to regurgitation, the frenula of the valve are put upon the stretch, and the free borders of the segments are brought into firm contact. In that way reflux of the contents of the cæcum into the ileum is to some extent prevented, but it must be noted that the circular muscle layer at the end of the ileum plays the part of a definite sphincter muscle.

The position of the ileo-cæcal orifice is marked, on the anterior surface of the abdomen, by the lower medial angle between the intertubercular and the right lateral lines. About 25 mm. (1 inch) below the ileo-cæcal orifice, and on a posterior plane, is the orifice of the vermiform process, which may be quite open, or it may be partly guarded by a semilunar fold of mucous membrane, the *valve of the vermiform process.*

Colon Ascendens.—The ascending colon passes upwards from the cæcum, through the upper part of the right iliac fossa, and through the right lumbar region to the right flexure of the colon in the right hypochondriac region. It varies from about 12.5 to 20 cm. (five to eight inches) in length. It is covered in front and at the sides by peritoneum, which binds it to the posterior wall of the abdomen. Occasionally it is attached to the posterior abdominal wall by an *ascending meso-colon.* Anteriorly, it is either in contact with the anterior wall of the abdomen, or it is separated from the abdominaf wall by coils of small intestine and the right free margin ol the greater omentum.

Dissection.—The peritoneum along the medial border of the ascending colon has already been divided. Now divide the peritoneum along the lateral border; then turn the cæcum and the ascending colon upwards, and remove the fatty areolar tissue which lies behind the colon. Note that the ascending colon lies anterior to the upper part of the right iliacus muscle, the crest of the right ilium, and, above the crest, in front of the fascia covering the right quadratus lumborum and the medial part of the aponeurosis of the origin of the right transversus abdominis. It is separated from the quadratus lumborum, however, not only by the anterior lamella of the lumbar fascia, but also by three nerves—the last thoracic, the ilio-hypogastric and ilio-inguinal. It is possible that the dissector will not be able to display the last thoracic nerve at this stage of the dissection.

Flexura Coli Dextra (O.T. **The Hepatic Flexure**).—The right flexure of the colon lies in the right hypochondrium, below and somewhat behind the anterior part of the lower surface of the right lobe of the liver, to the right of the gall-bladder, and in front of the lower part of the right kidney. It is covered by peritoneum except on its posterior surface, which is attached to the kidney by loose areolar tissue.

Colon Transversum.—The transverse colon extends first downwards and forwards and then upwards and backwards, from the right colic flexure, which is in contact with the under surface of the right lobe of the liver, in the right hypochondriac region, to the left colic flexure, which is in contact with the lower extremity of the spleen, in the left hypochondriac region. The lowest part of the curve usually crosses through the upper half of the umbilical region, and

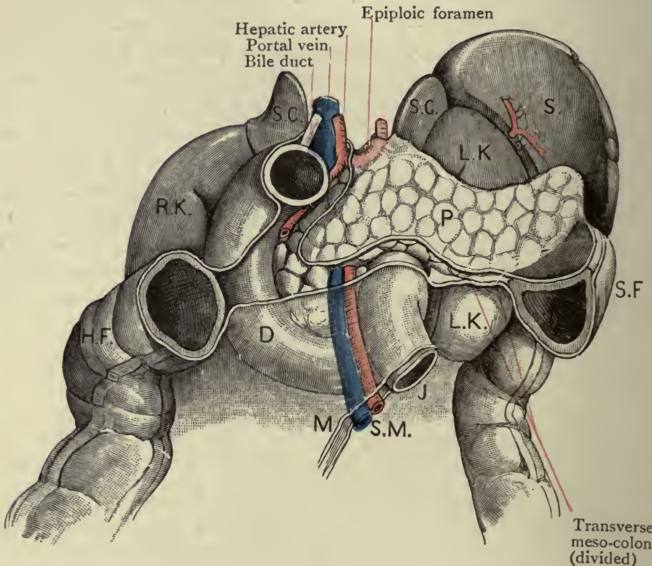


FIG. 155.—Duodenum, Pancreas, and Kidneys. (From the model by His.)

D. Duodenum.
H.F. Right flexure of the colon.
J. Jejunum.
L.K. Left kidney.
M. Mesentery.
P. Pancreas.
R.K. Right kidney.
S. Spleen.
S.C. Suprarenal gland.
S.F. Left flexure of the colon.
S.M. Superior mesenteric vessels.

a small but acute secondary curve, which is developed upon the left extremity of the main curve, lies against the medial border of the upper part of the descending colon. In the greater part of its extent it is enclosed in the posterior wall of the omental bursa, its lower border being attached to the greater curvature of the stomach by the greater omentum, whilst the posterior part of its upper border is attached to the pancreas by the transverse meso-colon. At the right extremity of the transverse colon, however, the transverse meso-colon is absent, and the posterior part of the wall of the transverse colon lies directly against the descending part of the duodenum and the adjacent portion of the head of the pancreas (Fig. 155). Anteriorly the transverse colon is in relation from right to left, with the inferior surface of the right lobe of the liver; the lower part of the posterior surface of the gall-bladder; the cavity of the omental bursa and the anterior two layers of the greater omentum, which separate it from the abdominal wall and the abdominal surface of the diaphragm. It has already been pointed out that before it enters the posterior wall of the omental bursa, that is before the transverse meso-colon commences, its posterior surface is in direct relation with the anterior surface of the descending part of the duodenum and the adjacent part of the head of the pancreas; then it lies in front of the third part of the duodenum, the upper end of the mesentery of the small intestine, the duodeno-jejunal flexure, and, finally, in front of coils of jejunum, which separate it from the lower pole of the left kidney. Its lower border is attached to the posterior two layers of the greater omentum. The right extremity of its upper border is in relation to the inferior surface of the liver and the posterior surface of the gall-bladder, and, in the remainder of its extent, it is attached posteriorly by the transverse meso-colon to the pancreas, and anteriorly it embraces the lower part of the greater curvature of the stomach, behind the line of attachment of the greater omentum to the lower border of that viscus.

The Transverse Meso-colon is a fold of peritoneum which connects the posterior part of the upper border of the transverse colon to the front of the head and to the anterior border of the body of the pancreas. It is not so extensive as the transverse colon, and is absent to the right of the head of the pancreas, where the transverse colon is in direct contact with the second part of the duodenum. The lower layer of the transverse meso-colon has already been removed, but the upper layer and the arteries which lie between the two layers are still in position and will enable the dissector to verify the attachments of the fold, which contains the middle colic artery and its branches, the accompanying veins, nerves, lymph glands, and lymph vessels, and the terminal portions of the upper branches of the right and left colic vessels and their anastomoses with the middle colic vessels.

Flexura Coli Sinistra (O.T. **The Splenic Flexure of the Colon**).—The left flexure of the colon is situated in the left hypochondriac region in close relation with the lower end of the spleen, the tail of the pancreas, and the lateral border of the left kidney. It is closely attached—(1) to the left extremity of the anterior border of the pancreas, by the left portion of the transverse meso-colon; (2) to the stomach, by the upper end of the left border of the greater omentum; (3) and to the abdominal surface of the diaphragm, opposite the eleventh rib in the mid-axillary line, by the phrenico-colic ligament. It is a more fixed flexure, and it is also a more acute flexure than the right flexure of the colon.

Colon Descendens.—The descending colon commences at the left flexure of the colon, in the left hypochondriac region, descends along the lower part of the lateral border of the left kidney, turns slightly medially to the apex of the lower pole of the kidney (Fig. 155), and then descends, vertically, to the left iliac crest, where it becomes the iliac colon. Its length varies from 10 to 15 cm. (four to six inches). Like the ascending colon it is covered in front and on each side by peritoneum, and its posterior surface is in relation with the extra-peritoneal fat which separates it from the fascia in front of the quadratus lumborum and the medial part of the aponeurosis of origin of the transversus abdominis. Its posterior and anterior relations are similar to those of the ascending colon (see p. 333).

Colon Iliacum.—The iliac portion of the colon commences at the termination of the descending colon, at the level of the upper and posterior part of the left iliac crest. It passes downwards and forwards to the region of the anterior superior iliac spine, and then turns medially, along the line of the inguinal ligament, to the brim of the pelvis minor, where it becomes the pelvic colon. Its length varies from 12.5 to 15 cm. (five to six inches). It does not possess a mesentery, but is covered with peritoneum anteriorly and along its sides. Posteriorly, it is separated by the extra-peritoneal fat from the iliacus, the psoas major, the femoral nerve (O.T. anterior crural), which lies in the groove between the two muscles, and its termination is in front of the left external iliac artery.

Before removing the ascending colon and the transverse colon, the dissector should again examine the longitudinal muscle fibres of the walls of the large intestine. They are arranged in the form of three longitudinal bands (*tæniæ coli*). The bands converge together on the medial and posterior aspect of the cæcum and fuse into a continuous layer on the vermiform process. At the other end of the large gut they unite again, on the wall of the rectum, first into two bands and then into a continuous layer, but in the intervening parts of the large intestine the bands are widely separated, one running along the anterior border (*tænia libera*), one along the posterior border (*tænia mesocolica*), whilst the third lies along the medial borders of the ascending and descending portions of the colon, and along the lower border of the transverse colon (*tænia omentalis*).

Dissection.—Place two ligatures round the upper part of the ascending colon, immediately below the right flexure of the colon; divide the intestine between the ligatures and remove the cæcum and ascending colon. Place two ligatures round the transverse colon, to the left of the right flexure of the colon, and another pair of ligatures round the left part of the transverse colon, near the left flexure of the colon. Divide the transverse colon between the ligatures at each end; then cut the transverse colon away from the remains of the transverse meso-colon and its contents. Take the separated portions of the large intestine to the sink, remove the ligatures and wash out the cavity of each part with running water.

When the washing is completed divide the separated portion of the transverse colon into two equal parts. In the case of one of the two parts, carefully divide the longitudinal bands of muscle, in the intervals between the sacculi; then pull upon the extremities of the separated portion of the gut and note (1) that the intestine lengthens, (2) that to a great extent the sacculi disappears, and (3) that when the tension is removed the piece of intestine does not return to its former length. This simple experiment shows that it is the shortness of the longitudinal bands which causes the puckered condition of the wall of the large gut.

Now open the ascending colon, and the two parts of the transverse colon, and note that the mucous membrane of the large intestine is devoid both of plicæ circulares and of villi. Note, further, that in the ascending colon and that part of the transverse colon in which the longitudinal bands of muscle were not divided the mucous membrane is thrown into a number of transverse and oblique folds and ridges some of which correspond with the constrictions between the sacculi but others are independent of those constrictions, whilst in that part of the transverse colon in which the longitudinal muscle bands were stretched, after the longitudinal bands of muscle were divided, folds and ridges of the mucous membrane are practically absent. Obviously, therefore, in ordinary circumstances the mucous membrane of the large intestine is much more extensive than the other layers of the wall of that part of the gut. Indeed if the mucous membrane is pulled out from the interior of the muscular tube it forms a tube about three times the length of the muscular tube. It is not as a rule possible to pull out a portion of the mucous tube from the interior of the muscular tube in formol-hardened dissecting-room subjects, but the experiment is easily made in the post-mortem room and the student should verify the above statements at the first favourable opportunity. Finally, hold the wall of the intestine to the light and note that whilst solitary lymph nodules are present there are no aggregated lymph nodules.

Structure of the Large Intestine.—The walls of the large intestine, like those of the small intestine, are formed by five layers or coats of tissue: (1) Serous, (2) Subserous, (3) Muscular, (4) Submucous, (5) Mucous.

The *Serous Coat* is complete only in the cases of the cæcum, which is surrounded with peritoneum, and the vermiform process, the transverse colon, and pelvic colon, which are provided with mesenteries. The ascending colon, the descending colon, the iliac colon and the rectum have no serous layer on their posterior aspects, and, in that respect, they correspond with the second and third parts of the duodenum. The anal canal is entirely devoid of serous covering.

The special peculiarity of the serous covering of the large intestine is the presence of numerous little fat-filled pouches of the membrane, called *appendices epiploicæ*, which project from the free margin of the gut, and which are present on all parts of the large intestine, except the vermiform process, the lower part of the rectum, and the anal canal.

The *Subserous Coat* is merely a thin stratum of areolar tissue which connects the serous layer with the muscular stratum.

The *Muscular Coat*, as in the case of the small intestine, consists of two strata, an external longitudinal stratum and an internal circular stratum.

The *longitudinal stratum* of muscle fibres forms a complete covering only in the vermiform process, the rectum, and the anal canal. In all other parts of the large intestine it is arranged in the form of three longitudinal bands whose positions have already been defined (see p. 337), but may here be re-stated—(1) One in relation to the attached surface (tænia mesocolica); (2) the second upon the anterior aspect (tænia libera); (3) and the third along the medial aspect of the gut, but, in the case of the transverse colon, the latter band is in relation to the inferior aspect of the tube (tænia omentalis). The bands commence at the point where the vermiform process joins the cæcum, and they terminate in the complete stratum of longitudinal muscle of the rectum. The longitudinal muscle of the rectum forms a complete covering, but is not of uniform thickness; on the contrary it is much thicker on the anterior and posterior aspects of the rectum than it is on the sides. In the anal canal the longitudinal muscular stratum passes between the external and the internal sphincters, and terminates in the skin at the margin of the anal orifice. The circular stratum of muscle, as in the case of the small intestine, forms a complete and continuous covering throughout the whole length of the large intestine, but it is most distinct in the constrictions between the sacculi. At the lower end of the anal canal it is greatly increased in thickness to form the internal sphincter ani.

The *Mucous Membrane* of the large intestine, as already pointed out, is entirely devoid of the plicæ circulares and villi, which are such prominent features of the mucous membrane of the small intestine. Its internal surface, however, is not perfectly smooth, but is raised into numerous transverse and oblique ridges which can be obliterated by extension of the gut.

As in the case of the small intestine, the mucous membrane of the large intestine contains enormous numbers of tubular intestinal glands, whose orifices can be seen with the aid of a low-power lens. It contains no aggregated lymph nodules, but embedded in it are numerous solitary lymph nodules which project into the submucous layer.

Structure of the Vermiform Process.—The vermiform process differs in structure from the main part of the large intestine in some important respects. Its serous layer is practically complete and is not provided with *appendices epiploicæ.* Its longitudinal stratum of muscle forms a complete covering. Its mucous membrane is relatively thin and the intestinal glands are poorly developed, but the most striking differential feature is the enormous amount of lymphoid tissue in the submucous layer. The lymphoid tissue is deposited in the form of nodules, of relatively large but varying size, which are so closely packed together that they form a practically continuous layer between the circular muscle and the mucous membrane.

The remaining portions of the large intestine will be considered in association with the dissection of the pelvis minor.

Dissection.—Place two ligatures round the descending colon, below the left colic flexure, and two more ligatures round the junction of the iliac with the pelvic colon; divide the bowel between each pair of ligatures and remove the descending and the iliac portions of the colon. Take the detached bowel to the sink, wash it thoroughly, open it, and note that, as in the other parts of the large intestine previously examined, the mucous membrane is devoid of villi and of plicæ circulares. After the separated parts of the intestine have been examined, clean the posterior wall of the abdomen in the regions from which they were removed and thus expose the structures which form their posterior relations. The structures behind the descending colon are the same as those behind the ascending colon (see p. 333), with the exception of the iliacus muscle, because the descending colon ends at the level of the crest of the ilium. Behind the iliac colon are the left iliacus muscle; the lateral cutaneous nerve of the thigh in front of the iliacus muscle; the left psoas major muscle; the femoral nerve in the angle between the iliacus and the psoas major; the spermatic vessels and the genito-femoral nerve in front of the psoas major; and the external iliac vessels at the inlet of the pelvis minor. After the structures mentioned have been displayed, clear away the remains of the transverse meso-colon from the front of the pancreas and proceed to the examination of the duodenum.

Duodenum.—It has already been noted that the duodenum is the first part of the small intestine; and it would have been examined, in proper sequence, immediately after the examination of the stomach, had it not been that a complete examination of it at that time would have interfered too much with the relations of other portions of the intestine which have now been removed.

The duodenum is from 25 to 30 cm. (ten to twelve inches) in length; it is the widest and the most fixed of the three parts of the small intestine, and its walls are thicker than those of the other two parts. It extends from the pylorus, which lies in the transpyloric plane half an inch to the right of the median plane, to the duodeno-jejunal flexure, which is situated at the left side of the second lumbar vertebra, slightly below the transpyloric plane and about an inch to the left of the median plane. Whilst passing from its commencement to its termination the duodenum describes a C-shaped curve, the concavity of the curve, which embraces the head of the pancreas, being directed upwards and to the left (Fig. 156).

For convenience of description the duodenum is divided into three parts—(1) superior, (2) descending, (3) inferior, and the

PLATE XVI

Fig. 156.—Dissection of the Abdomen.

The left lobe of the liver, the stomach, the lesser omentum, the greater omentum, and the transverse colon have been removed.

The greater part of the posterior wall of the omental bursa has been dissected away, and the peritoneum and extra-peritoneal fat have been removed from the posterior wall of the lower part of the abdomen.

1. Cut surface of left lobe of liver.
2. Falciform ligament.
3. Ligamentum teres.
4. Caudate lobe.
5. Left hepatic artery.
6. Right hepatic artery.
7. Hepatic duct.
8. Portal vein.
9. Fundus of gall-bladder.
10. Cystic duct.
11. Bile duct.
12. Duodenum, superior part.
13. Gastro-duodenal artery.
14. Superior pancreatico-duodenal artery.
15. Right gastro-epiploic artery.
16. Duodenum, descending part.
17. Kidney.
18. Right flexure of the colon.
19. Psoas major muscle.
20. Spermatic vessel crossing ureter.
21. Common trunk of ileo-colic and right colic arteries.
22. Genito-femoral nerve.
23. Right common iliac artery.
24. Middle sacral vessels.
25. Cæcum.
26. Ileum.
27. Vermiform process.
28. Pelvic colon.
29. Cut edge of lesser omentum.
30. Œsophagus.
31. Left crus of diaphragm.
32. Right crus of diaphragm.
33. Left inferior phrenic artery.
34. Left gastric artery.
35. Right inferior phrenic artery.
36. Spleen.
37. Pancreas.
38. Left gastro-epiploic artery.
39. Splenic artery.
40. Left flexure of the colon.
41. Duodeno-jejunal flexure.
42. Middle colic artery.
43. Left kidney.
44. Inferior mesenteric vein.
45. Left colic artery.
46. Psoas major muscle.
47. Inferior mesenteric artery.
48. Spermatic vessels.
49. Ureter.
50. Sigmoid arteries.
51. Genito-femoral nerve.
52. Superior hæmorrhoidal artery.
53. Iliac colon.

inferior part is subdivided into horizontal and ascending sections. The greater portion of the superior part is surrounded by peritoneum which is continuous below with the greater omentum, and above with the lesser omentum, but its terminal portion is devoid of peritoneum behind and below. The descending part is covered by the peritoneum in front, and on the right side, except where it is crossed by the transverse colon. The horizontal portion of the inferior part is covered in front and below; and the ascending portion of the inferior part is covered in front and on the left side. The remaining surfaces of the descending and inferior parts of the duodenum are devoid of peritoneum, and they lie in relation either with other viscera, or with large blood-vessels, or with the posterior wall of the abdomen.

Pars Superior.—The superior part of the duodenum is two inches in length; it lies in the epigastric region, and for about an inch or more from the pylorus it is enveloped by the same two layers of peritoneum which invest the stomach; consequently, it enjoys a limited degree of movement. Its terminal portion is covered with the peritoneum only on its anterior and superior surfaces. Its position and relations are dependent upon the degree of distension of the stomach.

When the stomach is empty, and the pylorus is immediately to the right of the median plane below the left lobe of the liver, the superior part of the duodenum passes backwards and to the right and slightly upwards, along the inferior surface of the liver, to the neck of the gall-bladder. Its upper surface is in contact at first with the under surface of the left lobe of the liver, then it crosses the line of the umbilical fissure of the liver, and in the latter part of its course it is in relation with the lower surface of the quadrate lobe of the liver. When the stomach is distended the pylorus moves slightly to the right to the under surface of the quadrate lobe. Then the superior part of the duodenum is slightly shortened and it runs upwards and backwards beneath the quadrate lobe, and its terminal extremity is lodged in a depression at the left end of the porta hepatis. In both cases its termination bends suddenly downwards into the descending part. The relations of the superior part of the duodenum are as follows: *above* and *in front*, the visceral surface of the liver; *below*, the pancreas; *behind*, the vena cava, the bile-duct, the gastro-duodenal artery, the portal vein, and the upper part of the neck of the pancreas.

Pars Descendens.—The descending part of the duodenum is from 7.5 to 10 cm. (three to four inches) in length. At its commencement it lies in the epigastric region, immediately below the liver, and it descends, along the medial face of the right lateral plane, into the umbilical region, to the level of the middle of the third lumbar vertebra, where it turns to the left and joins the inferior part. It is immovably fixed in its position; it is covered with peritoneum only on its anterior and right lateral surfaces, and it is crossed by the commencement of the transverse colon which does not possess a mesentery, and is therefore in direct contact with the descending part of the duodenum (Fig. 156). *Posteriorly*, it rests upon the right border of the inferior vena cava and presents a variable relation to the renal vessels and the anterior surface of the right kidney in the neighbourhood of the hilum. *To the right* is the right flexure of the colon; and *its left side* is in contact with the head of the pancreas, which is moulded upon the medial side of the descending part of the duodenum.

The bile-duct and the pancreatic duct open into the descending part of the duodenum a little below its middle, at the junction of its medial and posterior aspects.

Pars Inferior.—The first or horizontal portion of the inferior part of the duodenum crosses the posterior wall of the abdomen at the level of the third lumbar vertebra, its direction being from right to left and slightly upwards. To the right of the median plane it lies in the upper part of the umbilical region, but near its termination it rises above the subcostal plane into the epigastric region. Its anterior and inferior surfaces are covered with peritoneum. It lies behind the transverse colon; and it is crossed by the upper part of the root of the mesentery of the small intestine, containing the superior mesenteric artery and vein. Posteriorly, it rests against the right ureter, the right psoas major muscle, the right internal spermatic artery, the inferior vena cava, and the abdominal part of the aorta (Fig. 156). Its upper border is in relation with the head of the pancreas and the inferior pancreatico-duodenal artery; and its lower border is in relation with coils of the jejunum.

The second or ascending portion of the inferior part of the duodenum passes upwards from the level of the upper part of the third lumbar vertebra to the duodeno-jejunal flexure. In front and on the left it is covered with peritoneum, and it is in relation with the upper part of the jejunum. To the right it is in relation, anteriorly, with the head of the pancreas and, posteriorly, with the aorta. Behind it lie the anterior border of the left psoas major muscle, and the left sympathetic trunk; and the left renal vein crosses behind it, unless the vein lies at a somewhat relatively higher level, behind the lower surface of the pancreas.

Dissection.—Cut through the peritoneum as it passes from the duodenum to the right kidney on the right, and from the duodenum to the posterior wall of the abdomen below and to the left; then turn the descending part of the duodenum medially, and the inferior part upwards, to examine the posterior relations noted above. The superior part of the duodenum and the attached portion of the pyloric end of the stomach can be turned to the right for the examination of the posterior relations of the superior part of the duodenum.

Suspensory Muscle of the Duodenum and the Root of the Mesentery.—The duodeno-jejunal flexure and the root of the mesentery are held in position and prevented from slipping downwards on the posterior wall of the abdomen by a band of involuntary muscular fibres which fixes them to the diaphragm. The band is called the suspensory muscle of the duodenum. It is attached above to the diaphragm, on the right side of the œsophageal aperture. From there it passes downwards, on the left side of the cœliac artery, to the duodeno-jejunal flexure, into which a large number of its fibres are inserted. The remaining fibres enter the mesentery and find attachment to the peritoneum. In the child the suspensory muscle is well marked and easily isolated, but in the adult it loses its distinctly muscular character and becomes more or less blended with neighbouring tissues.

Pancreas.—The pancreas is an elongated gland which stretches across the posterior wall of the abdomen behind the stomach. For the most part it is situated in the epigastric region, only a small portion of its left extremity being placed in the left hypochondriac region. Its form, as in the case of the other solid organs contained within the abdominal cavity, is greatly modified by the condition of the hollow viscera in its immediate vicinity, and its true shape can be ascertained only by fixing it *in situ* by injections of some hardening reagent. It may be described as consisting of a *head*, a *neck*, a *body*, and a *tail*.

The *head of the pancreas* is the flattened portion of the gland which lies in front of the vertebral column and occupies the concavity of the duodenum. Posteriorly it is in relation with the inferior vena cava and to some extent also with the aorta. Its anterior surface is crossed by the transverse colon. As a rule its marginal lobules show a tendency to extend over the anterior surface of the descending and inferior parts of the duodenum so as to overlap the gut in the vicinity of its concavity. Certain other relations may be noticed in connection with the head of the pancreas, viz., (1) the bile-duct passes down behind it, in close relation to the second part of the duodenum; (2) the pyloric part of the stomach lies in front of it, above the transverse colon; (3) its lower part, the *uncinate process*, is prolonged to the left, along the upper border of the inferior part of the duodenum, behind the superior mesenteric vessels, and then upwards behind the neck of the pancreas; (4) the vena portæ is formed in front of the upturned part of the uncinate process and behind the neck of the pancreas.

The *neck of the pancreas* (Symington) is a narrow, constricted portion of gland-substance which springs from the anterior aspect of the head, nearer its upper than its lower margin. It constitutes the link of connection between the head and the body of the pancreas, and, as it proceeds to the left and forwards, it lies in front of the commencement of the vena portæ and of the termination of the superior mesenteric vein. Those vessels intervene between the neck and the anterior surface of the upper part of the uncinate process. The left part of the anterior surface of the neck is covered by the layer of peritoneum which forms the posterior wall of the omental bursa, and it is usually somewhat depressed by the pyloric end of the stomach, which rests upon it. The right part of the anterior surface is separated from the superior part of the duodenum by the gastro-duodenal artery.

The *body of the pancreas* extends from the anterior and left extremity of the neck, backwards and to the left, and slightly upwards, across the lower part of the left suprarenal gland, and the front of the left kidney, to the short *tail*, which lies in relation with the spleen. It presents *anterior*, *inferior*, and *posterior surfaces*, which are separated from each other by *superior*, *anterior*, and *inferior borders*. The *anterior surface* looks forwards and upwards, and is covered by the peritoneum of the posterior wall of the omental bursa. In the greater part of its extent, the anterior surface supports the postero-inferior surface of the stomach, and is hollowed for its reception. Immediately adjoining the neck a smooth rounded prominence, *the tuber omentale of the pancreas*, projects upwards and forwards, from the junction of the anterior surface and the upper border of the pancreas, above and to the left of the lower part of the lesser curvature of the stomach. The tuber omentale abuts against the lesser omentum, which separates it from the omental tubercle of the liver.

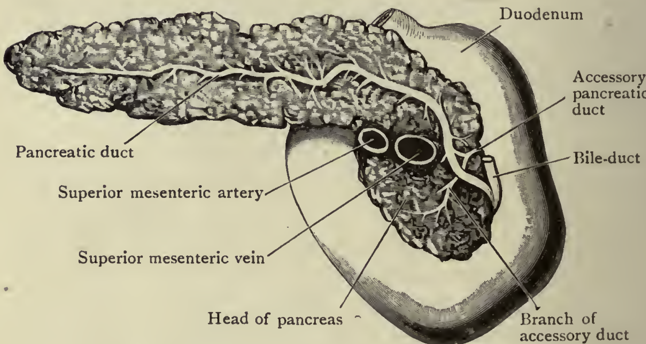


FIG. 157.—Dissection of the posterior surface of the Pancreas to show its Ducts. (Birmingham.)

The *inferior surface* of the body of the pancreas varies greatly in extent, in association with the varying degrees of intestinal pressure to which it is subjected from below. It looks downwards and rests upon the duodeno-jejunal flexure, coils of the small intestine, and the left part of the transverse colon close to the left flexure of the colon. It is completely covered with peritoneum which is continuous with the posterior layer of the transverse meso-colon.

The gastric pressure exerted on the pancreas from above, and the counter-pressure which is exerted by the intestine on the inferior surface of the organ from below, varying, as they do in the same subject, according to the condition of those hollow viscera, determine, in a great measure, the shape of the body of the pancreas. The body of the pancreas has the appearance of being wedged in between the two layers of the root of the transverse meso-colon.

The splenic artery pursues a wavy course along the superior border of the pancreas, whilst the transverse meso-colon is attached to its anterior border.

The *tail of the pancreas* abuts against the visceral aspect of the spleen, and it usually rests in a small depression on the lower and medial part of the gastric concavity of that organ (Fig. 169, p. 360).

> ***Dissection.***—**To display the posterior relations of the body and neck of the pancreas, raise the tail from the spleen ; then, working from left to right, carefully separate the body and the neck from the structures which lie behind them.**

The *posterior surface* of the body of the pancreas lies in front of the middle portion of the left kidney ; in front of the hilum of the kidney and the structures which pass through it ; in front of the lower part of the left suprarenal gland ; in front of the left crus of the diaphragm ; and it joins the left and anterior end of the neck. The splenic vein runs behind its upper border, between it and the kidney and the left suprarenal gland, to reach the back of the neck, where it joins with the superior mesenteric vein to form the portal vein. The inferior mesenteric vein passes behind the posterior surface to join the splenic vein, and the left internal spermatic vein also ascends behind it to join the left renal vein, which issues from the hilum of the kidney and passes to the right, behind the posterior surface of the body of the pancreas, to join the inferior vena cava behind the head of the pancreas.

Ducts of the Pancreas.—The ducts of the pancreas are, as a rule, two in number—a main duct and an accessory duct. Both run within the gland substance.

The main *pancreatic duct* (*Wirsungi*) begins at the tail of the gland by the union of the small ducts issuing from the lobules in that region, and it proceeds towards the right. During its course it gains considerably in size, being joined by numerous small ducts which issue from the various groups of lobules. At the neck of the gland it bends downwards into the substance of the head. If the gland substance is carefully divided, little difficulty will be experienced in discovering the main duct. The extreme whiteness of its walls renders it conspicuous. Close to the duodenum the pancreatic duct comes in contact with the bile-duct, and, in company, both pierce the coats of the descending part of the duodenum upon its posterior and medial aspect, and terminate in its wall in a dilatation, the *ampulla of Vater*, which opens into the cavity of the duodenum at the apex of a papilla called the *papilla duodeni*.

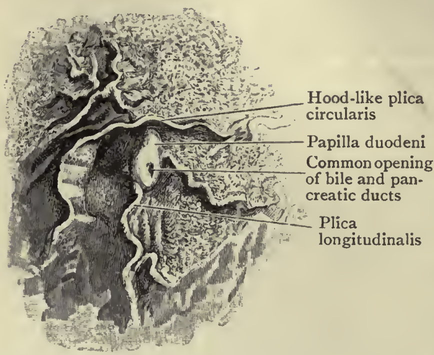


FIG. 158.—The Papilla Duodeni, situated at the upper end of the Plica Longitudinalis. (Birmingham.)

The *accessory duct* (*Santorini*) is small, and arises in the lower part of the head of the gland. It usually has an independent opening into the duodenum, above and anterior to the opening of the main duct. It may communicate with the main duct.

The dissector is now in a position to study the *biliary ducts* and the *portal vein.*

Ductus Biliferi.—The ducts which carry the bile, secreted by the liver, from the liver and the gall-bladder to the duodenum are —(1) the right and left hepatic ducts, (2) the common hepatic duct, (3) the cystic duct, and (4) the bile-duct. Bile flows only in one direction through the hepatic ducts and the bile-duct, that is, towards the duodenum; but through the cystic duct it flows sometimes to and sometimes from the gall-bladder.

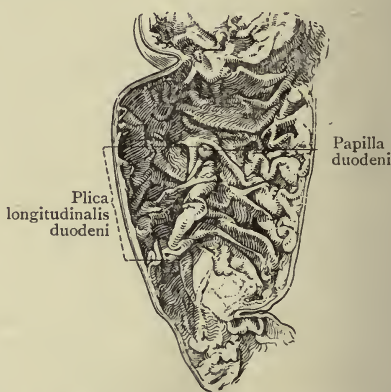


FIG. 159.—Pars Descendens Duodeni, opened from the right side. Showing the duodenal papilla at the upper end of the plica longitudinalis under a hood-like plica circularis.

The *right* and *left hepatic ducts* issue from the corresponding lobes of the liver into the porta hepatis, and unite within it to form the *common hepatic duct.* The latter, which is about 25 mm. (one inch) in length, descends into the upper part of the lesser omentum, where it unites with the cystic duct (which has already been examined, p. 281) to form the bile-duct. As it descends, the common hepatic duct passes either anterior to or posterior to the right branch of the hepatic artery.

Ductus Choledochus (O.T. Common Bile-Duct).—The ductus choledochus is from 8 to 10 cm. (three and a half to four inches) long. In the first part of its course it lies in the right free border of the lesser omentum, to the right of the hepatic artery, and in front of the epiploic foramen, from which it is separated by the right border of the portal vein and the posterior layer of the lesser omentum. In the second part of its course it passes behind the first part of the duodenum, with the gastro-duodenal artery, close to the posterior or right end of the neck of the pancreas; then, entering on the third part of its course, it dips behind the right border of the head of the pancreas, and, coming into relation with the main duct of the pancreas, it accompanies that duct into the wall of the second part of the duodenum, where they both enter the ampulla of Vater. The ampulla opens into the cavity of the gut by a single orifice, which is situated on the duodenal papilla (Figs. 118, 159, 160).

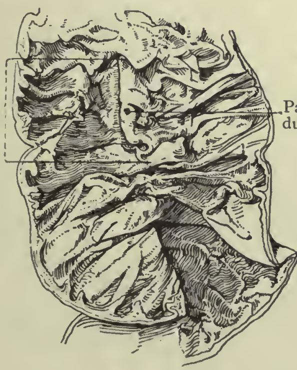


FIG. 160.—Pars Descendens Duodeni, opened from the right side. Showing the duodenal papilla at the middle of the plica longitudinalis.

Dissection.—**Make a vertical incision in the anterior wall of the second part of the duodenum, nearer its right than its left**

border. At the upper and lower ends of the vertical incision make short transverse incisions, and turn aside the flaps, so formed. Clean the interior of the duodenum with a sponge, and then examine the mucous membrane. Note that the mucous membrane of the descending part is thrown into numerous and large plicæ circulares, and that, as a rule, it is deeply stained by bile. Look for a longitudinal fold of the mucous membrane, the *plica longitudinalis*, which lies at the junction of the medial and posterior walls, nearer the lower than the upper end. It serves as a guide to the duodenal papilla, which frequently lies at its upper extremity, usually concealed by one of the largest of the plicæ circulares (Fig. 159). Pass a small probe through the

FIG. 161.—Pars Descendens of the Duodenum, opened from the right side. Showing the aperture for the passage of the bile and pancreatic juice on the upper part of the posterior face of the plica longitudinalis. There was no duodenal papilla.

opening on the apex of the papilla into the ampulla. Make an opening in the lower part of the bile-duct, and pass a small probe along the duct into the ampulla ; perform the same operation on the main pancreatic duct ; then cut down through the medial wall of the gut and open up the lumina of the ducts, the cavity of the ampulla of Vater, and its orifice of communication with the interior of the duodenum.

The dissector should note that whilst the duodenal papilla usually lies at the upper end of the plica longitudinalis (Figs. 158, 159) it may be situated on the middle of the plica (Fig. 160), and it may be absent. In the latter case the aperture through which the bile and the pancreatic juice enter the duodenum lies in a recess, at the side of the upper part of the plica longitudinalis (Fig. 161).

Vena Portæ (Portal Vein).—Blood is carried to the liver both by the hepatic artery and by the portal vein. The hepatic artery, which carries arterial blood, has already been examined, p. 300. The portal vein, which carries the venous blood from the whole of the abdominal part of the alimentary canal, except the anal canal, and from the spleen, the pancreas, and the gall-bladder, must now be studied. It is

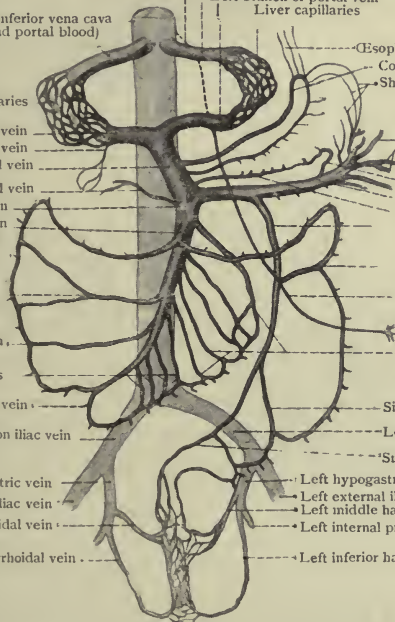


FIG. 162.—Schema of the Portal System of Veins and its connections with the Systemic System. It must be remembered that the systemic blood carried by the hepatic artery also enters the liver capillaries, therefore the hepatic veins contain both portal and systemic blood.

formed by the union of the superior mesenteric and splenic veins, behind the neck of the pancreas, between the neck and the upturned uncinate process of the head of the pancreas. It ascends, behind the first part of the duodenum and in front of the inferior vena cava, to the lower margin of the epiploic foramen, where it leaves the vena cava, enters the lesser omentum, and continues upwards, in front of the epiploic foramen and behind the bile-duct and the hepatic artery (Fig. 156), to the right extremity of the porta hepatis; there, after enlarging slightly, it divides into a wide, short right branch, and a longer and narrower left branch. Its length is about 5 cm. (two inches), it is, therefore, relatively short, but it is a wide vessel and is capable of carrying a large stream of blood. In addition to its two main tributaries, viz., the superior mesenteric and the splenic veins, the vena portæ receives the coronary vein of the stomach and the right gastric vein. Occasionally the inferior mesenteric vein joins its commencement, instead of opening into the splenic vein. The right branch receives the cystic vein and then enters the right lobe of the liver. The left branch runs to the left along the porta, crosses the fossa for the umbilical vein, and enters the left lobe of the liver. As it crosses the umbilical fossa it is joined, anteriorly, by the ligamentum teres and some small para-umbilical veins, and, posteriorly, by the ligamentum venosum. The small para-umbilical veins, which join the left branch, run along the ligamentum teres of the liver, and communicate, at the umbilicus, with the superficial veins of the abdominal wall.

Vena Lienalis.—The splenic vein commences by the union of a number of tributaries which issue from the hilum on the gastric surface of the spleen. It runs backwards through the lieno-renal ligament, and then passes to the right, to its union with the superior mesenteric vein behind the neck of the pancreas. As it runs from left to right it lies behind the upper part of the posterior surface of the pancreas and in front of the left kidney, the left suprarenal gland, and the abdominal aorta, crossing the aorta between the origins of the cœliac and the superior mesenteric arteries. It conveys blood not only from the spleen, but also from the stomach and the pancreas. The blood from the stomach is conveyed to it by the left gastro-epiploic and the short gastric veins, which pass backwards in the gastro-splenic ligament and join its splenic tributaries; and as it passes along the pancreas it receives tributaries from that gland.

Dissection.—Cut through the œsophagus immediately below the diaphragm; detach the stomach from the diaphragm by severing the gastro-phrenic ligament, and from the spleen by cutting through the remains of the gastro-splenic ligament and dividing the short gastric arteries, the left gastro-epiploic artery, and the accompanying veins. Remove the separated portion of the stomach and examine its structure.

Structure of the Stomach.—The coats of the stomach are five in number, viz. :—

1. Peritoneal, or serous.
2. Subserous.
3. Muscular.
4. Submucous.
5. Mucous.

The *serous coat*, consisting of the peritoneal membrane, can be stripped off best by the fingers. The *subserous coat* is composed of a little areolar tissue which intervenes between the muscular and serous strata. The branches of the two vagi nerves can now be followed, as they spread out upon the two surfaces of the stomach.

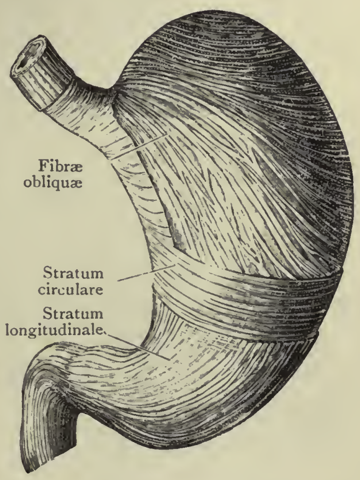


FIG. 163.—Dissection of the three layers of Muscular Fibres in the Wall of the Stomach.

The *muscular coat* of the stomach consists of involuntary muscle fibres which are arranged in three strata; an *external longitudinal stratum*, an *intermediate circular stratum*, and an *internal oblique stratum*. The external longitudinal stratum is continuous above with the longitudinal fibres of the œsophagus and below with the longitudinal fibres of the duodenum. It is best marked along the lesser curvature, and in the region of the pylorus, where it takes part in the formation of the pyloric sphincter; on the greater curvature, on the fundus, and on the surfaces of the stomach it is extremely thin. Nevertheless it is the only muscular stratum which forms a continuous and unbroken sheet. The intermediate circular stratum commences as a series of U-shaped loops, which only partially encircle the body of the stomach. At the upper part of the lesser curvature they are continuous with the superficial circular fibres of the œsophagus. Thence they extend over both surfaces of the body of the stomach but fail to reach the great curvature, and they are absent over the fundus. Further to the right they form complete circles, and in the region of the pylorus, where they are greatly increased in number, they form the thick powerful sphincter of the pyloric orifice (Fig. 168). The oblique internal fibres are continuous with the deep circular fibres of the œsophagus. They are deficient along the lesser curvature and in the pyloric region. They are spread over the body of the stomach as scattered strands, but they completely ensheath the fundus where the proper circular stratum is deficient, and in that region they assume a circular arrangement.

FIG. 164.—Posterior Wall of an Empty and Contracted Stomach. Showing the folds of the mucous membrane.

A, Œsophagus ; B, Pylorus.

The *submucous coat* is composed of lax areolar tissue. It intervenes between the muscular and mucous coats, and binds them loosely to each other in such a manner that the mucous membrane can glide freely upon the internal surface of the muscular coat.

The *mucous coat* must be studied from the inside of the stomach. Open up the viscus by running the scissors along the lesser curvature. The gastric mucous membrane will then be seen to be thick, soft, and pulpy. In the dissecting-room the student cannot obtain a proper idea of its natural colour. In infancy it is rosy red, but as life advances it gradually becomes paler, and in old age it presents a brownish hue owing to the presence of pigment. When the mucous membrane is cleansed and examined with a pocket-lens, its surface is observed to present a pitted appearance. Innumerable polygonal depressions are brought into view; they are larger and better marked near the pylorus than in the vicinity of the fundus. At the bottom of the depressions are the mouths of the minute tubular glands of the gastric mucous membrane (Fig. 165).

The mucous membrane has little elasticity, and, consequently, when the stomach contracts and becomes empty the membrane is thrown into projecting folds or rugæ which, for the most part, run in the longitudinal direction and

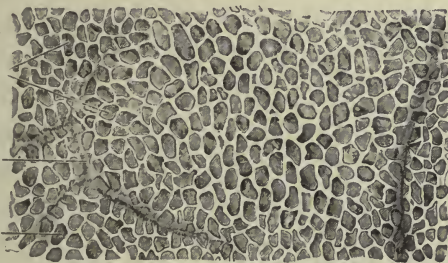


FIG. 165.—Mucous Membrane of the Stomach magnified 25 diameters.

occupy the cavity of the organ (Figs. 164, 166). As the stomach expands the folds open out, and they disappear when complete distension is attained.

> ***Dissection.*—Extend the incision already made in the second part of the duodenum upwards into the first part, to within a short distance of the pyloric constriction, and examine the pyloric orifice and the pyloric canal.**

Pyloric Orifice and Pyloric Canal.—The extremity of the pyloric canal protrudes into the commencement of the duodenum, so that, when viewed from the duodenal side, it presents the appearance of a smooth, rounded knob, surrounded by a shallow furrow or fornix, and having a small puckered orifice, the *pyloric opening*, in its centre (Fig. 167). Its resemblance to the external orifice of the uterus is very striking. When the stomach has been properly hardened *in situ* the pyloric orifice is almost invariably found tightly closed. It is only on rare occasions that it is actually open. In such cases it is circular, and surrounded by a ring-like ledge which has been called the pyloric valve. During life the pyloric opening may be regarded as being always rigidly closed, except during digestion, when it opens intermittently, and at irregular intervals, to allow material to be squirted from the stomach into the duodenum.

The muscular coat of the pyloric canal is modified to adapt it to its function. It is provided with a powerful sphincteric apparatus. Both the circular and longitudinal muscular fibres are present in greater mass than in any other part of the organ. The circular fibres are disposed in the form of a thick sphincteric muscular cylinder which surrounds the entire length of the pyloric canal. At the duodeno-

FIG. 166.—Anterior Wall of a Slightly Distended Stomach. Showing the folds of the mucous membrane.

A, Œsophagus ; B, Pylorus.

pyloric constriction the margin of this cylinder becomes increased in thickness, forming thereby the strong muscular ring which encircles the pyloric orifice and constitutes the *pyloric sphincteric ring.* The knob-like appearance presented by the extremity of the pyloric region, when viewed from the interior of the duodenum, is produced by the presence of the muscular ring beneath the mucous membrane. The sphincteric cylinder which surrounds the pyloric canal varies much in its thickness in accordance with different degrees of contraction of the canal.

The longitudinal muscle fibres likewise form a thick layer on the superficial aspect of the sphincteric cylinder and ring. They are uniformly disposed around the pyloric canal, but comparatively few of them pass superficially over the duodeno-pyloric constriction to become continuous with the corresponding fibres of the muscular coat of the duodenum. As they approach the duodenum the deeper longitudinal fibres of the pyloric canal leave the surface and penetrate the substance of the pyloric sphincteric ring. There can be little doubt that the arrangement forms an effective apparatus, antagonistic to the pyloric sphincteric ring, by means of which, when the sphincter relaxes, the pyloric orifice may be dilated. There is thus a constrictor and a dilatator of the pylorus.

In suitable specimens this arrangement of the muscle fibres may be seen by the naked eye when a longitudinal

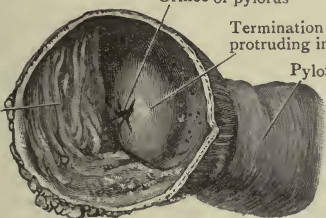


FIG. 167.—Small portion of the Pyloric part of the Stomach with part of the Duodenum attached.

section is made through the pyloric canal in the plane of the two curvatures of the stomach (Fig. 168).

> ***Dissection.***—**Open the duodenum from end to end by an incision carried along its convex border; then clean it with a sponge.**

Structure of the Duodenum.—The structure of the duodenum is generally similar to that of other parts of the small intestine. That is, its wall is formed by five main coats or layers: (1) serous; (2) subserous; (3) muscular; (4) submucous; (5) mucous. The serous coat is complete only over the greater portion on the superior part (see p. 342). All the other parts are covered by peritoneum only on two faces—the descending part in front, except where it is crossed by the transverse colon, and on the right; the horizontal section of the inferior part in front and below, and the ascending section of the inferior part in front and on the left; the subserous, muscular, and submucous layers have no special features of importance. There are, however, special features to be noted in association with the mucous layer. It is covered throughout by villi, but plicæ circulares are present only in the descending and inferior parts. There, however, they are very large and abundant. In the lower portion of the descending part a longitudinal fold, the plica longitudinalis duodeni, which has already been examined (p. 350), cuts across the line of the plicæ circulares. It terminates above at the papilla duodeni, through which the bile and pancreatic juice are poured into the duodenum

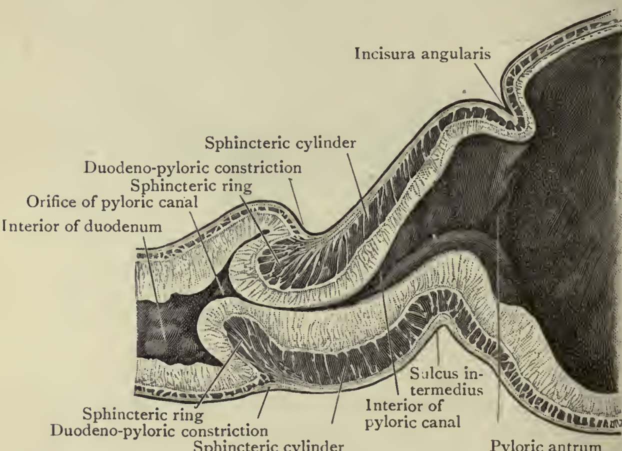


FIG. 168.—Pyloric Canal and Pyloric Antrum of the Stomach opened up by section in the plane of the two curvatures.

Opening on the surface of the mucous membrane are the orifices of numerous intestinal glands, and intermingled with them, especially in the pars superior, are the orifices of the special *duodenal glands*.

Dissection.—Take a segment of the wall of the first part of the duodenum and pin it down, with its mucous surface undermost, to the bottom of a cork-lined tray filled with water. Its coats may then be dissected. They are in all respects similar to those already examined in connection with the jejunum (p. 325). If the dissection is carried on until the deep surface of the submucous coat is exposed by the removal of the entire muscular coat, a view of the duodenal glands may be obtained. They appear as whitish specks, about the size of hemp-seed, in the submucous tissue. They are most numerous close to the pylorus, and gradually disappear about two inches beyond it.

Lien (Spleen).—The spleen is a solid organ which lies deeply in the left part of the costal zone, and is altogether out of sight in the undisturbed condition of the viscera, but it is exposed when the stomach is removed. It lies very obliquely in the abdominal cavity, its upper end being much nearer the median plane and much further back than its lower end. Its long axis is directed from above downwards and laterally, and also to some extent forwards. For the most part it lies in the left hypochondrium, but its upper end extends medially beyond the left lateral plane, so that fully a third of the organ is situated in the epigastric region.

The spleen, when properly hardened *in situ*, has the shape of an irregular tetrahedron. Its four surfaces are the diaphragmatic, the gastric, the renal, and the colic. The *diaphragmatic surface*, which is the most extensive of the four, is convex. It looks backwards and laterally; it rests against the posterior part of the diaphragm, to the curvature of which it is adapted, and it is separated by the diaphragm from the lower parts of the left lung and pleura, and from the ninth, tenth, and eleventh ribs.

The three remaining surfaces, the gastric, the renal, and the colic, look towards the interior of the abdomen; they are all in close apposition with the adjacent viscera and, consequently, they are grouped together as the visceral surfaces. Of the three the gastric is the largest, the colic is usually the smallest, and all three are concave. They are separated from one another by three ridges which radiate from an inconspicuous prominence called the *intermediate angle*, which forms the apex of the tetrahedron (Fig. 169). One of the ridges, the *margo intermedius*, forms a salient border, which ascends from the intermediate angle to the superior angle, and separates the gastric from the renal surface. The superior angle is curved forwards on itself to some extent, and approaches close to the left suprarenal gland. A second and much shorter ridge passes backwards from the intermediate angle, and terminates at the posterior angle; it separates the renal surface from the colic surface. The third ridge, which is often rounded and indistinct, passes forwards from the intermediate angle to the anterior angle, and separates the gastric from the colic surface.

The *gastric surface* is the largest of the three visceral areas. It is deeply concave, and is moulded upon the fundus and the upper part of the posterior surface of the body of the stomach. Within its area, a short distance in front of the margo intermedius which separates it from the renal surface, there is a longitudinal cleft, the hilum, through which the vessels and nerves enter and leave the organ. The hilum is not uncommonly broken up into several segments. Behind the hilum, and immediately in front of the intermediate angle, there is a *pancreatic impression*

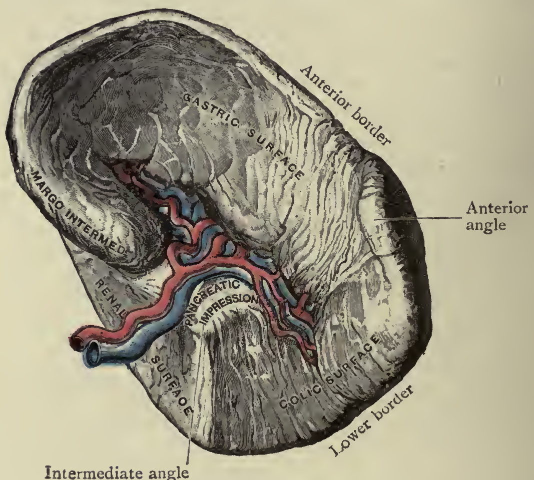


FIG. 169.—The Spleen (visceral aspect).

of very variable depth and extent, in which the tail of the pancreas rests.

The *renal surface* is also concave. It is of variable extent, and is applied to the lateral portion of the upper part of the anterior surface of the left kidney and to the adjacent part of the lateral border of the kidney. It is separated from the gastric surface by the margo intermedius, and from the diaphragmatic surface by the posterior border which extends from the superior to the posterior angle.

The *colic surface* is usually the smallest of the three visceral surfaces. It lies immediately above the inferior border, which separates it from the diaphragmatic surface, and between the anterior, posterior, and intermediate angles. It is triangular in outline and concave in contour, and it rests upon the left flexure of the colon and upon the phrenico-colic ligament.

The *diaphragmatic surface* is the largest of the four surfaces. It is separated from the gastric surface by the notched anterior border, from the renal surface by the posterior border, and from the colic surface by the inferior border. It rests against the left part of the posterior portion of the diaphragm, by which it is separated from the lower parts of the left lung and pleura, and from the ninth, tenth, and eleventh ribs.

Of the several borders which separate the different surfaces from one another the anterior, the posterior, and the inferior are the most conspicuous. The *anterior border* lies between the diaphragmatic and the gastric surfaces. It extends from the superior to the anterior angle. It is crossed by two or more notches which can be felt, through the abdominal wall, when the spleen is enlarged, and which serve, therefore, for purposes of identification. The *posterior border* runs from the superior to the posterior angle, and separates the diaphragmatic from the renal surface. It is occasionally notched. The *inferior border*, which runs from the anterior to the posterior angle, separates the diaphragmatic from the colic surface.

Of the four angles the anterior is the most prominent and distinct. It lies at the junction of the anterior and the inferior borders, at the level of the eleventh rib in the mid-axillary line, and is the most anterior part of the spleen.

The spleen is entirely surrounded by peritoneum, and it is attached to two of the neighbouring viscera by folds of that membrane: (1) To the fundus and the vertical part of the body of the stomach by the gastro-splenic ligament, and (2) to the anterior surface of the left kidney by the lieno-renal ligament. Both the ligaments are attached to the spleen along the margins of its hilum (Fig. 135). It is also attached by the splenic artery to the coeliac artery, and by the splenic vein to the portal vein. It is supported in position not by its peritoneal and vascular attachments, but by the general intra-abdominal pressure, which is due to the tonic contraction of the abdominal muscles, and which compresses the adjacent viscera against it, and also by the phrenico-colic ligament, upon which its inferior border and part of its inferior surface rest.

The form of the spleen varies very greatly with the varying degrees of distension of the hollow viscera which are related to its visceral aspect. There is good reason to believe that the tetrahedral form which is described above is associated with an empty or only slightly distended stomach and a well-distended intestine. When, however, the stomach is distended and the intestine is more or less empty, the basal surface partially or even entirely disappears, and then the spleen assumes a form similar to that of the segment of an orange (Shepherd).

Structure of the Spleen.—As the spleen will be required when the relations of the left kidney are studied, the dissector should obtain a sheep's spleen for the purpose of studying the structure of the organ. He will find that it is enveloped by two coats—(1) serous; (2) fibro-elastic. The *peritoneal investment* adheres so closely to the subjacent fibrous coat that it can be removed only with difficulty. With regard to the *fibro-elastic tunic* (tunica propria), it should be noted that processes, the *trabeculæ of the spleen*, proceed from its deep surface and dip into the substance of the organ. The trabeculæ constitute the supporting framework of the *gland-pulp*; therefore it will be found impossible to strip off the fibrous coat of the spleen without at the same time lacerating its surface. Make a section through the organ, and carry a portion of it to the tap. By squeezing it and allowing the water to run freely over it, the dissector may obtain a view of the trabecular framework.

Dissection.—**The sympathetic plexuses in the upper part of the abdomen may now be studied with advantage. Throw the tail and body of the pancreas and the superior part of the duodenum over to the right. Next, turn to the left cœliac ganglion, which was displayed when the posterior wall of the omental bursa was removed; it lies between the left border of the cœliac artery and the medial border of the left suprarenal gland (see p. 298). From the medial border of the left cœliac ganglion trace sympathetic nerve fibres across the front of the aorta, round the root of the cœliac artery, to the opposite ganglion, which lies behind the inferior vena cava. To expose the right cœliac ganglion, therefore, it is necessary to displace to the right the portion of the inferior vena cava which lies behind the first part of the duodenum and to fix it out of the way with hooks or pins. Follow each cœliac ganglion upwards and backwards to its union with the greater splanchnic nerve of the same side, and follow the splanchnic nerve to the point where it passes into the abdomen by piercing the crus of the diaphragm of the corresponding side.**

Sympathetic Plexuses.—In connection with the sympathetic nervous system three large plexuses are formed in front of the vertebral column: they are the cardiac plexus, in the thorax; the cœliac plexus, in the upper part of the abdomen proper; and the hypogastric plexus, in the lower part of the abdomen proper.

The cœliac plexus (O.T. *solar plexus*), which is by far the largest of the three, consists of the two cœliac (O.T. semilunar) ganglia and the numerous nerve bundles which connect the ganglia together.

It lies at the level of the lower part of the last thoracic and the upper part of the first lumbar vertebra, in front of the crura of the diaphragm and the uppermost part of the abdominal portion of the aorta, between the medial margins of the suprarenal glands, and around the cœliac artery. Numerous offshoots arise from it and pass either along the adjacent arteries, or to the suprarenal glands and the kidneys; the offsets constitute the secondary plexuses.

Ganglia Cœliaca (O.T. *Semilunar Ganglia*).—The cœliac ganglia are of irregular shape; they are frequently broken up into a number of connected segments, and they are so large that they are frequently mistaken by students for lymph glands. The upper extremity of each ganglion is joined by the great splanchnic nerve of the same side, whilst the lower part, which is often more or less detached, is connected with the lesser splanchnic nerve.

Plexus Gastricus Superior.—The superior gastric plexus springs from the front of the cœliac plexus. It accompanies the left gastric artery to the lesser curvature of the stomach and distributes twigs to both surfaces of that viscus.

Plexus Hepaticus.—The hepatic plexus also springs from the front of the central part of the cœliac plexus. It is joined by twigs from the left vagus nerve, and accompanies the hepatic artery, the portal vein and the bile-duct to the liver. At the lower margin of the lesser omentum, it gives off twigs which accompany the gastro-duodenal artery and its right gastro-epiploic branch; they constitute the *inferior gastric plexus*.

Plexus Lienalis.—The splenic plexus, like the superior gastric and the hepatic plexuses, springs from the median and anterior part of the cœliac plexus. It accompanies the splenic artery to the spleen, and is joined by twigs from the right vagus nerve. It gives offshoots along the various branches of the artery.

Plexus Renalis.—Each renal plexus consists of numerous nerves which spring chiefly from the lateral part of the corresponding cœliac ganglion. Some will be found, however, arising from the strands of the cœliac plexus and others from the aortic plexus. The *lowest* or *third splanchnic nerve*, when it is present, joins the renal plexus. Thus constituted, the filaments of the renal plexus run with the renal artery to the hilum of the kidney, and are distributed within the gland substance. Several twigs are given also to the spermatic plexus. A few scattered ganglia are usually found in connection with the renal plexus.

Plexus Suprarenalis.—The dissector will be struck with the large number of nerves which supply the suprarenal glands. They are derived chiefly from the cœliac ganglion of the same side, but many come from the strands of the cœliac plexus. Each suprarenal plexus is directly continuous below with the renal plexus, and it is connected above with the phrenic plexus. The lowest splanchnic nerve usually contributes a branch to the suprarenal plexus, and the point at which it joins is marked by a small ganglion.

Plexus Phrenicus.—The filaments composing each phrenic plexus take origin from the upper part of the cœliac ganglion of the same side, and are distributed with the inferior phrenic artery to the inferior surface of the diaphragm, but they do not follow rigorously the branches of that vessel. At first they lie subjacent to the peritoneum, but soon they penetrate between the fleshy fasciculi and establish communications with the phrenic nerve. On the right side a small ganglion is formed on the inferior surface of the diaphragm at the point of junction between the phrenic plexus and the phrenic nerve. In addition to its diaphragmatic branches the phrenic plexus contributes filaments to the suprarenal plexus, and, on the right side, to the hepatic plexus.

Plexus Mesentericus Superior.—The superior mesenteric plexus springs from the lower part of the central portion of the cœliac plexus and descends, with the superior mesenteric artery, in the root of the mesentery of the small intestine. It sends offsets along the branches of the artery.

Plexus Aorticus Abdominalis.—The abdominal aortic plexus is formed mainly by branches derived from the ganglia of the abdominal parts of the sympathetic trunks, but it is connected, above, with the cœliac and superior mesenteric plexuses, and, below, branches which issue from it are prolonged downwards across the fronts of the common iliac arteries into the hypogastric plexus.

Plexus Spermaticus.—Each spermatic plexus receives filaments from the aortic plexus and from the renal plexus of the same side. It accompanies the corresponding internal spermatic artery and gives branches to the ureter as well as to the testis. In the female the corresponding plexus is called the *ovarian plexus* and accompanies the ovarian vessels.

Plexus Mesentericus Inferior.—The inferior mesenteric plexus springs from the aortic plexus, and at its commencement it contains a ganglion. It accompanies the inferior mesenteric artery and gives secondary offshoots along the branches of the artery.

***Dissection.*—Removal of the Spleen, Pancreas, and Duodenum.**—The dissector should now proceed to the removal of the spleen, the pancreas, and the duodenum, which should be kept together and preserved, so that they can be replaced in position when the relations of the kidneys are being studied.

Cut through—(1) the splenic artery, about 18 mm. (three-quarters of an inch) from its origin from the cœliac trunk; (2) the portal vein, about 25 mm. (one inch) above the union of the superior mesenteric and splenic veins; (3) the superior mesenteric artery, 12.5 mm. (half an inch) below its origin from the aorta; (4) the gastro-duodenal branch of the hepatic artery. Fix the splenic vein to the posterior surface of the pancreas with a few stitches. Pull the spleen over towards the right side and cut through the left layer of the lieno-renal ligament, which is still in position; then remove the spleen, the pancreas, and the duodenum from the abdomen.

Removal of the Liver.—The general position and connections of the liver have been considered, and the left lobe has been detached and laid aside (see p. 281). The right lobe must now be separated from the parts of which it is connected. Strip the peritoneum from the anterior surface of the inferior vena cava, from the point where it was exposed by the removal of the superior part of the duodenum to the point where it disappears into the fossa venæ cavæ on the posterior surface of the liver. Raise the liver as much as possible, and, to the right of the inferior vena cava, cut through the layer of the peritoneum which is reflected from the lower part of the posterior surface of the liver to the diaphragm. That layer is the *lower layer of the coronary ligament*. At the base of the liver the lower layer of the coronary ligament becomes continuous with the right triangular ligament, which must also be divided. After the right triangular ligament is divided, pull the liver downwards as far as possible, and cut through the falciform ligament, which connects the anterior and superior surfaces of the liver to the anterior abdominal wall and to the diaphragm. Divide that ligament from before backwards, and note, as its posterior extremity is approached, that its right lateral layer becomes continuous with the *upper layer of the coronary ligament*, which passes from the posterior border of the upper surface of the liver to the diaphragm. Divide that layer from right to left, and be careful not to injure the upper part of the abdominal portion of the inferior vena cava, which lies immediately behind it, a little to the right of the line of attachment of the falciform ligament. Now, with the right hand, pull the right lobe of the liver forwards and to the left, detaching its posterior surface from the diaphragm with the fingers of the left hand, until the right border of the fossa for the inferior vena cava is reached ; then separate the vena cava from the fossa, with the fingers, from below upwards, until the large hepatic veins are reached as they pass out of the upper part of the posterior surface of the liver into the anterior wall of the inferior vena cava, immediately below the diaphragm. Divide those veins carefully with the knife and remove the right lobe of the liver from the abdomen.

After the right lobe of the liver has been removed from the abdomen, attach the left lobe to it with long pins, and study the various surfaces and parts of the gland with the utmost care.

The Surfaces of the Liver.—The anterior surface, and the base or right lateral surface, are smooth, convex, and covered with peritoneum. They are separated from each other by a rounded and indistinct border.

The Base is in relation with the right part of the diaphragm, from the level of the seventh to the level of the eleventh rib, in the mid-axillary line ; and it is separated by the diaphragm from the lower part of the right pleural sac and right lung.

The Anterior Surface is in relation with the anterior part of the diaphragm, on each side of the sub-costal angle, and, opposite the sub-costal angle, with the posterior surfaces of the sheaths of the recti muscles ; and the lower border of the falciform ligament is attached to it nearer to its left than to its right extremity.

The Superior Surface is smooth also and it is covered with peritoneum. On the right and on the left, where it fits into the corresponding cupolæ of the diaphragm, and is separated by the diaphragm from the lungs and pleural sacs, it is convex, and more convex on the right side than on the left. In the intermediate area, where the diaphragm separates it from the pericardium and the heart, it is slightly concave, and running antero-posteriorly across the depressed area is the line of attachment of the falciform ligament, which separates the upper surface of the right lobe from the upper surface of the left lobe. The line of attachment of the falciform ligament to the upper surface terminates, posteriorly,

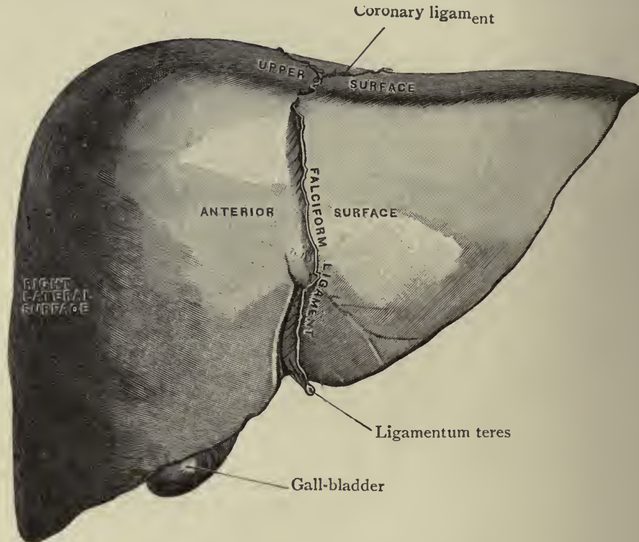


FIG. 170.—Anterior Surface of the Liver.

at the upper end of the fossa for the ductus venosus, and from that point the line of attachment of the left triangular ligament extends to the left, on the posterior part of the upper surface of the left lobe. A short distance to the right of the posterior end of the line of attachment of the falciform ligament, the posterior border of the upper surface is notched by the upper end of the fossa for the inferior vena cava. The portion of the posterior border of the upper surface which lies between the upper ends of the fossa for the ductus venosus and the fossa for the inferior vena cava is the upper end of the caudate lobe.

The inferior and *posterior surfaces* are each divided into segments by a right and a left pair of fossæ, which run parallel with the sagittal plane. The pair of sagittal fossæ, which separate the lower and the posterior surfaces into right and left lobes, are the *fossa for the umbilical vein*, on the inferior surface, and the *fossa for the ductus venosus*, on the posterior surface. The pair of sagittal fossæ, which segment the lower and posterior surfaces of the right lobe, are the *fossa for the gall-bladder* on the lower surface, and the *fossa for the inferior vena cava*, on the posterior surface.

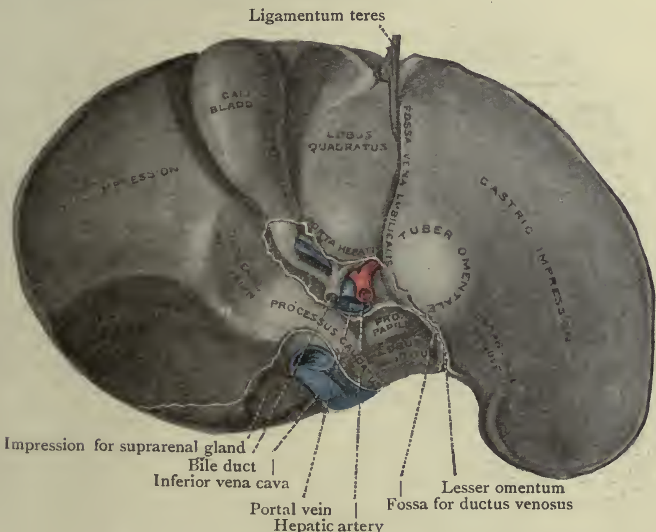


FIG. 171.—The Inferior or Visceral Surface of the Livei

The Inferior or Visceral Surface of the Liver looks downwards, backwards and to the left, and rests partly upon viscera situated at a lower level in the abdomen and partly upon the front of the lesser omentum. It is separated into a larger right and a smaller left segment or lobe by the fossa for the umbilical vein. On the inferior surface of the right lobe, close to its posterior border and at its left extremity, is the *porta hepatis* or hilum of the liver, through which the hepatic artery and the portal vein pass into the liver, and the hepatic ducts and the lymph vessels pass out. It connects the posterior part of the fossa for the umbilical vein with the posterior part of the fossa for the gall-bladder. The portion of the right lobe which lies in front of the porta, and between the fossa for the gall-bladder on the right and the fossa for the umbilical vein on the left, is the *quadrate lobe*, which frequently bears impressions made by the pylorus and the first part of the duodenum. Behind the porta hepatis, and between the lower ends of the fossa for the ductus venosus and the fossa for the inferior vena cava, is the lower end of the caudate lobe, which is usually divided, by a shallow sulcus, into a nodular left or *papillary process*, which projects downwards into the cavity of the omental bursa, and a right, band-like *caudate process*, which connects the lower end of the caudate lobe with the main part of the inferior surface of the right lobe. The remainder of the inferior surface of the right lobe is marked by three shallow impressions: (1) at the right extremity of the porta hepatis is an antero-posterior sulcus, the *duodenal impression*, for the second part of the duodenum; (2) to the right of the fossa for the gall-bladder is the *colic impression*, for the right flexure of the colon; (3) behind the colic impression is the *renal impression*, for the upper part of the anterior surface of the right kidney. Occasionally a fourth impression exists behind the duodenal impression; it is the *suprarenal impression*, which is always present on the posterior surface and may extend on to the inferior surface.

The inferior surface of the left lobe is marked by an elevation, the *tuber omentale*, and a depression, the *gastric impression*. The tuber omentale adjoins the left extremity of the porta hepatis and, when the liver is in position, it rests against the lesser omentum, immediately above the lesser curvature of the stomach. The gastric impression occupies the remainder of the lower surface of the left lobe lying in front and to the left of the tuber omentale.

The Posterior Surface of the Liver (Figs. 172 and 173).—The posterior surface is moulded upon the front of the vertebral column, from which it is separated by the diaphragm and the lower part of the descending thoracic aorta. It presents, therefore, a deep hollow corresponding to the bodies of the vertebræ and the structures in front of them. Immediately to the left of the fossa of the ductus venosus there is a smooth notch or groove, the *œsophageal impression*, which leads downwards into the gastric impression on the under surface of the left lobe. The groove lies anterior to the œsophagus. To the left of the œsophageal groove the posterior surface of the left lobe merges into a sharp margin which separates the superior from the inferior surface.

It has been pointed out that the œsophageal groove in the liver is usually occupied by the prominent anterior margin of the œsophageal opening of the diaphragm, which, in the first instance, must be regarded as being responsible for the depression (Birmingham).

On the posterior surface of the right lobe there may be recognised—(1) the lobus caudatus (O.T. lobus Spigelii);

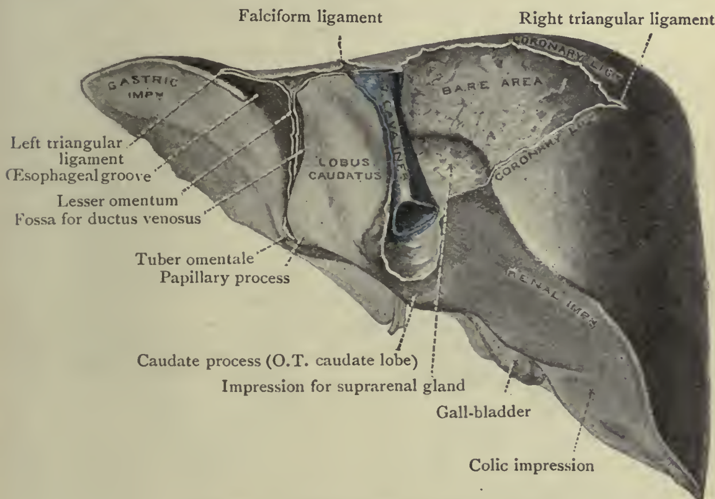


FIG. 172.—Posterior Surface of the Liver.

(2) the fossa for the inferior vena cava; and (3) an extensive "bare area" devoid of peritoneum.

The *lobus caudatus* (O.T. *lobus Spigelii*) is the portion of liver substance which lies between the fossa of the ductus venosus and the fossa of the inferior vena cava. Its lower end appears on the inferior surface of the liver immediately behind the porta hepatis. It is divided into the papillary process, on the left, and the caudate process, on the right (Fig. 172). The caudate lobe forms the bottom of the vertebral hollow, and is separated from the bodies of the tenth, eleventh, and twelfth thoracic vertebræ by the diaphragm and the lower part of the descending thoracic aorta.

Fossa Venæ Cavæ.—The *fossa for the inferior vena cava* is a deep groove placed on the right side of the caudate lobe. It ascends almost perpendicularly, and sometimes it is converted into a tunnel by a bridge of liver substance which passes behind the vein from the one side to the other. In its anterior wall the orifices of the divided hepatic veins will be seen.

The *bare area* of the posterior surface of the liver is triangular in form, and lies to the right of the fossa for the

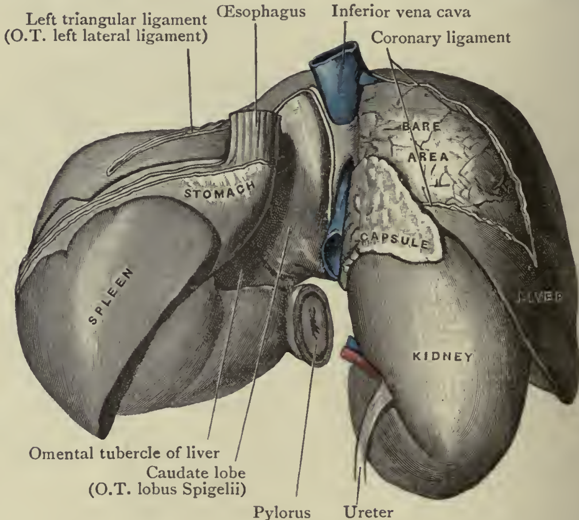


FIG. 173.—Liver, Right Kidney, Spleen, and Stomach, as seen from behind. Drawing made from a model prepared by the reconstruction method.

vena cava. It forms the greater part of the posterior surface of the right lobe, and is bounded above and below by the lines of reflection of the coronary ligament. For the most part it is convex, and it is connected with the diaphragm by loose areolar tissue, and some minute veins which unite the portal vessels of the liver with the systemic vessels of the diaphragm; but close to the lower end of the fossa for the vena cava there is a well marked depression, the *suprarenal impression*, which lodges the upper part of the right suprarenal gland.

Porta Hepatis (O.T. **Transverse Fissure**).—The porta hepatis, or hilum of the liver, is the cleft on the posterior part of the lower surface of the right lobe through which the vessels and ducts enter and leave the liver. It lies near the posterior border of the lower surface, between the lower end of the caudate lobe posteriorly and the quadrate lobe anteriorly. It extends, transversely, from the upper and posterior end of the fossa for the gall-bladder, on the right, to the upper and posterior end of the fossa for the umbilical vein, on the left.

In the upper part of the lesser omentum, immediately below the porta, the bile-duct, the hepatic artery, and the portal vein are in close relation to each other, the artery lying to the left, the duct to the right, and the portal vein behind and between them. The branches of the three structures enter the porta in the same relative positions, and, as they pass into it, they become enclosed in a sheath of the fibrous capsule of the liver (O.T. Glisson's capsule). Trace them for a short distance into the substance of the liver and note that the portal vein branches like an artery, and wherever it divides, there also will the hepatic artery and hepatic duct be found to divide. The branches of the three structures, therefore, traverse the liver substance in company, and the fibrous capsule is prolonged into the liver with them, and follows them in their ramifications. The student is now in a position to understand the meaning of the term "*portal canal.*" It is employed to denote a channel in the liver substance, lined by a prolongation of the fibrous capsule, and holding in its interior a branch of the portal vein, a branch of the hepatic artery, and a branch of the hepatic duct.

Vessels of the Liver.—Blood enters the liver—(1) by the *hepatic artery*, (2) by the *portal vein*; whilst it passes away from the liver by the *hepatic veins*.

The *hepatic artery* is a branch of the cœliac artery. It carries arterial blood for the nourishment of the liver substance and divides into two branches which enter the liver at the extremities of the porta hepatis (p. 300).

The *portal vein* carries venous blood which it has gathered from the spleen, pancreas, and gall-bladder, and from the entire length of the abdominal portion of the alimentary canal (with the exception of the anal canal of the rectum). It reaches the inferior surface of the liver at the right extremity of the porta hepatis, where it divides into its two terminal branches. The terminal part of the portal vein, just before it divides, is slightly expanded, forming the *sinus of the portal vein*. The *right branch* is a short wide vessel which immediately sinks into the right lobe of the liver; the *left branch*, much longer and considerably smaller, extends to the left along the bottom of the porta hepatis, and at the left extremity of that furrow it crosses the fossa for the umbilical vein and enters the left lobe of the liver. As it crosses the fossa for the umbilical vein the left branch of the portal vein is joined in front by the ligamentum teres, whilst the ligamentum venosum is attached to it behind.

The *hepatic veins*, which lead the blood out of the liver, have an arrangement altogether different from the vessels which enter at the porta hepatis. They converge towards the fossa for the vena cava, on the posterior surface of the liver, and cannot be said to have any course outside the liver, as they open at once into the vena cava inferior. Their gaping mouths will be found at the upper end of the fossa for the vena cava. Trace the hepatic veins for a short distance into the substance of the gland. They are remarkable for the tenuity of their walls, and also for the very small quantity of areolar tissue which separates them from the hepatic substance; indeed, the areolar tissue is so scarce around the large veins that it is hardly appreciable to the naked eye; it is entirely absent from the smaller veins, and their walls rest directly against the hepatic lobules.

A section should now be made through the liver substance and the cut surface examined. The portal veins can be readily distinguished from the hepatic veins. The following are the points of difference:—

Portal Veins.	Hepatic Veins.
1. Are always accompanied by a branch of the duct and a branch of the hepatic artery.	1. Are solitary and not accompanied by any other vessel.
2. Mouths usually collapsed.	2. Mouths usually open and gaping.
3. Walls thicker.	3. Walls exceedingly thin.
4. Walls separated from the liver substance by the fibrous capsule.	4. Walls apparently in direct apposition with the liver substance.

Structure of the Liver.—Very little of the structure of the liver can be learned in the dissecting-room. It is completely enveloped by a fibrous capsule (O.T. Glisson's). This is thick where the peritoneum is absent, but very thin where that membrane is spread over the gland. The liver substance presents a mottled appearance, and when torn or ruptured the surface exhibits a granular aspect. The minute particles which give rise to this appearance are the hepatic lobules. In the human liver these are not completely separated from each other.

Glandulæ Suprarenales (O.T. **Suprarenal Bodies or Capsules**).—The suprarenal glands are two small, flattened bodies, which are placed upon the upper ends of the kidneys. Each suprarenal body surmounts the corresponding kidney after the fashion of a helmet, and is prolonged downwards for a short distance upon its anterior surface and its medial border. The suprarenal glands lie in the epigastric region, and rest posteriorly upon the diaphragm.

The Right Suprarenal Gland is, as a rule, triangular in form, and rests, by its base, upon the anterior and medial aspect of the upper end of the right kidney. It is placed between the posterior surface of the right lobe of the liver and the adjacent portion of the diaphragm at the side of the vertebral column.

The *anterior surface*, which looks laterally as well as forwards, is moulded into two areas by the pressure of the inferior vena cava and the liver—(1) The medial area is a narrow vertical strip which lies behind the inferior vena cava; (2) the lateral area is adapted to the posterior and inferior surfaces of the liver. Only a small and variable part of the lower portion of the anterior surface of the right suprarenal gland is covered with peritoneum. On the upper part of the impression for the vena cava, not far from the apex of the gland, a short fissure, termed the *hilum*, may be observed. From it issues a short wide suprarenal vein which immediately enters the inferior vena cava. The *posterior surface* of the right suprarenal gland is divided by a salient, curved ridge into an upper, flat part, which is applied to the diaphragm, and a concave, lower part, sometimes called the base; the concavity is occupied by fat which separates the gland from the kidney.

The Left Suprarenal Gland is semilunar in form, and, as a rule, is slightly larger than the right. Its position on the kidney is also somewhat different. It is usually placed on the medial border of the kidney above the hilum, but it may extend to the upper end.

The *anterior surface* presents, not far from its lower end, a very obvious *hilum* with a large emerging vein. The greater part of this surface is separated from the postero-inferior surface of the stomach by the posterior wall and the cavity of the omental bursa, and it forms a portion of the stomach bed. The lower portion of the anterior surface is covered by the pancreas and crossed by the splenic vessels, and is not in relation to the peritoneum. Occasionally the spleen extends so far medially that it lies in relation to the upper part of the anterior surface of the left suprarenal gland (see Fig. 155, p. 334), but that condition is uncommon. The *posterior surface* is subdivided into two areas by a curved ridge, as on the right side. The upper area is flat, and lies against the left crus of the diaphragm; the lower area is hollowed out and is in relation to the kidney, a considerable amount of fat intervening.

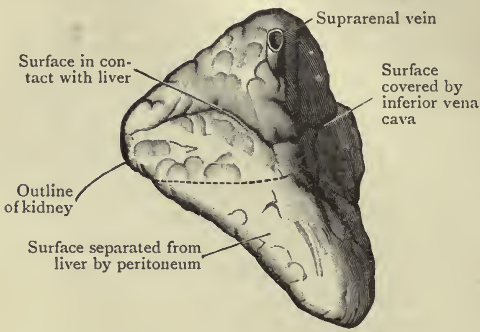


FIG. 174.—Anterior Surface of Right Suprarenal Gland.

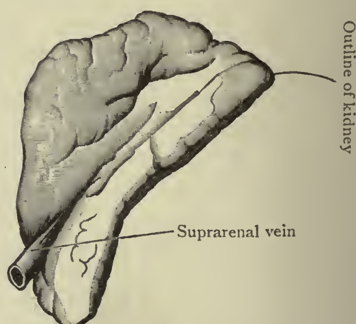


FIG. 175.—Anterior Surface of Left Suprarenal Gland.

The dissectors have already observed the abundant nerve supply to the suprarenal glands from the cœliac plexus. Their blood supply is equally rich. No fewer than three arteries enter the substance of each, viz.—the *superior*, *middle*, and *inferior suprarenal arteries*.

When a section is made through the suprarenal gland it is seen to consist of an external, firm portion, termed the *cortex*, and of a soft, pulpy, dark-coloured internal substance, called the *medullary part*.

Renes.—The kidneys are situated behind the peritoneum, against the posterior wall of the abdomen—one on each side of the vertebral column. Each is enveloped by a capsule of loose areolar tissue, the meshes of which are loaded with soft, pliable fat. Take the fat away, and be careful to preserve the *suprarenal gland*, which lies upon the upper end of each kidney.

Each *kidney* is placed opposite the bodies of the last thoracic and the upper three lumbar vertebræ. It extends from the upper border of the last thoracic vertebra to the middle of the body of the third lumbar vertebra; and it lies obliquely—its upper end being somewhat nearer the median plane than its lower end. The kidneys lie for the most part in the hypochondriac and epigastric regions. As a rule the left kidney is confined entirely to those districts; but the right kidney, which is generally slightly lower in the abdomen than the left, crosses the subcostal plane, and a small portion of its inferior extremity lies in the right lumbar and the adjoining part of the umbilical region. The difference between the two sides is probably due to the great bulk of the right lobe of the liver. On each side the twelfth rib lies behind the kidney, and the right kidney does not, as a rule, extend beyond the upper border of that rib, but the left kidney may reach the lower border of the eleventh rib. The lower end of each kidney is separated by a short but variable interval from the crest of the ilium.

The average length of a kidney is 10 cm. (four inches); its breadth is about 6 cm. (two and a half inches); and its average weight is 130 grms. (four and a half ounces) in the male, but somewhat less in the female. It is a solid organ, very pliable, and of a brownish-red colour. The left kidney is, as a rule, slightly longer and narrower than the right kidney.

Form of the Kidney.—The form of the kidney is so characteristic that the term "reniform," or "kidney-shaped," has become common in descriptive language. The *anterior surface* looks laterally and forwards, and presents impressions corresponding to the viscera in contact with it; whilst the *posterior surface* is directed medially and backwards, and is moulded accurately upon the parts which support it. The *extremities* are rounded, and the superior end is usually thicker and more massive than the inferior. The *lateral border*, smooth and convex, is directed backwards and laterally;

whilst the *medial border* is concave, and looks medially and forwards.

The kidneys present many changes in form, according to the amount and the kind of pressure which is exerted upon them by contiguous viscera. In most cases, however, and on both sides, there is on the anterior surface of the organ a point of maximum convexity—a place where the kidney substance is raised in the form of a marked prominence or bulging. Above and below that eminence the anterior surface falls away towards each extremity, in the form of an inclined or sloping plane of greater or less obliquity. The impressed districts indicate pressure exercised on the anterior surface of the kidney in two directions, and the intervening eminence is the result of the pressure and counterpressure. The characteristic appearance is more constant and better marked in the case of the left kidney.

Upon the upper part of the anterior surface of the *left kidney* are placed the left suprarenal gland, the stomach, the spleen, and the pancreas. They exercise, collectively, a downward and backward pressure, chiefly through changes in the condition of the stomach. Upon the lower part of the left kidney the counterpressure is produced by the intestinal canal, which, as a rule, presses upwards and backwards.

Resting upon the upper part of the *right kidney* is the liver, whilst in contact with the lower part is the colon. The colon presses on the kidney in an upward and backward direction. To that pressure the liver offers a passive resistance, except perhaps in the case of the slight influence which it conveys in a downward direction from the diaphragm, and in a backward direction from the anterior abdominal wall.

The pressure and counterpressure, which produce so marked a conformation of the anterior surface of each kidney, must exercise also an important influence in maintaining the organ in its place, and securing it in that part of the abdominal cavity in which it lies. Still, it is doubtful if the influences have so potent an effect on the right as on the left side. The right kidney is embedded to a greater or less extent in the liver, and the pressure of the liver no doubt exerts an influence in fixing the kidney in position.

Ligaments fixing the kidney to the abdominal wall are described, and it is easy to demonstrate that the extra-peritoneal tissue in which it lies becomes condensed in the regions above and below into indefinite fibrous lamellæ, but it is doubtful if these can have much effect in maintaining the kidney in its place.

Hilum of the Kidney.—The medial border of each kidney presents a longitudinal fissure called the *hilum*, for the admission and egress of the vessels, nerves, lymph vessels, and duct (Fig. 176). The hilum is bounded anteriorly and posteriorly by thick lips, and leads into a deep recess or cavity in the kidney, which is termed the *renal sinus*. The ureter and the renal vessels pass between the lips of the hilum. They will be found to have the following general relations

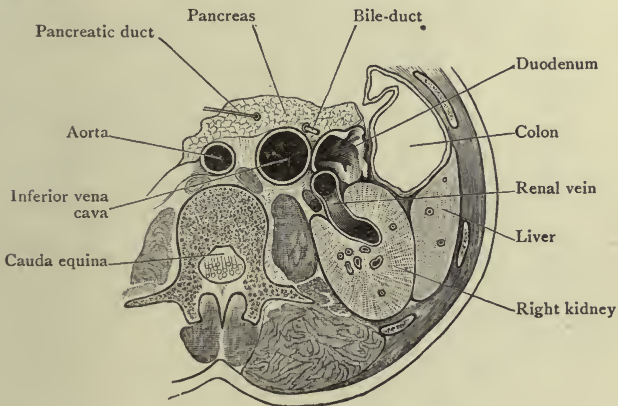


FIG. 176.—Section through Abdomen at the level of the second lumbar vertebra.

from before backwards: (1) branches of the renal vein; (2) branches of the renal artery; (3) ureter or renal duct.

Anterior Surface of the Right Kidney.—The anterior surface of the right kidney may present three impressions, viz. a hepatic, a colic, and a duodenal. The *hepatic impression*, which indicates the area of contact with the inferior surface of the right lobe of the liver, occupies almost the whole of the upper two-thirds of the anterior surface. Over that district the kidney is sometimes sunk deeply into the liver. The right suprarenal gland, which rests, as a rule, on the upper extremity of the right kidney, extends downwards, for a very short distance, on the anterior surface of the organ, between it and the liver. With the exception of the narrow strip covered by the suprarenal gland, the hepatic area on the anterior surface of the kidney is covered with peritoneum. The *colic impression* corresponds to the lower part of the surface, and sometimes it exhibits a marked degree of obliquity. The right colic flexure and the commencement of the transverse colon are in contact with the colic area. The posterior surfaces of those portions of large intestine are devoid of peritoneum, and are bound to the kidney by

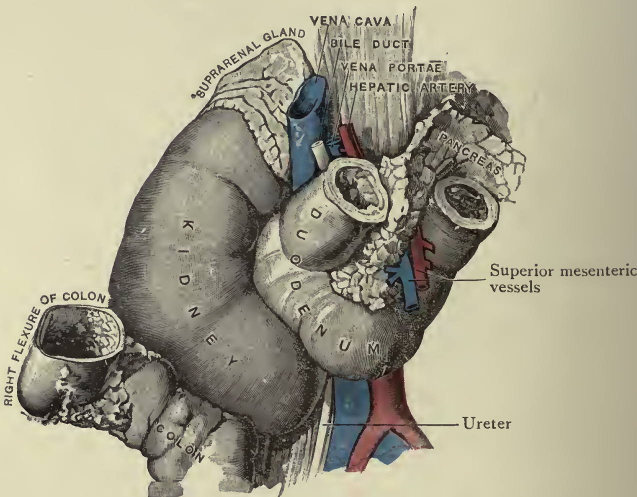


FIG. 177.—Right Kidney and Duodenum.

areolar tissue. The *duodenal impression*, or area of contact with the descending part of the duodenum, is in the neighbourhood of the hilum, and varies greatly both in position and extent (Figs. 155, 177).

The lower pole of the right kidney, and the area of the anterior surface between the suprarenal gland above, the colon below, and the duodenum medially are covered with peritoneum, but the peritoneum is separated from the remaining parts of the anterior surface by the viscera mentioned.

Anterior Surface of the Left Kidney.—The left suprarenal gland, the spleen, the stomach, and the pancreas are in contact with the upper part on the anterior surface of the left kidney. The left *suprarenal gland*, as a rule, occupies a narrow district along the medial border, from the level of the hilum to the summit of the organ. The *spleen* is in contact over an area immediately adjoining the lateral convex border. The extent of the splenic field varies considerably in different subjects. The *pancreas* stretches across the left kidney about its middle. The *stomach* is in contact with the left kidney over the triangular interval which is left between the left suprarenal gland, the spleen, and the pancreas, and that

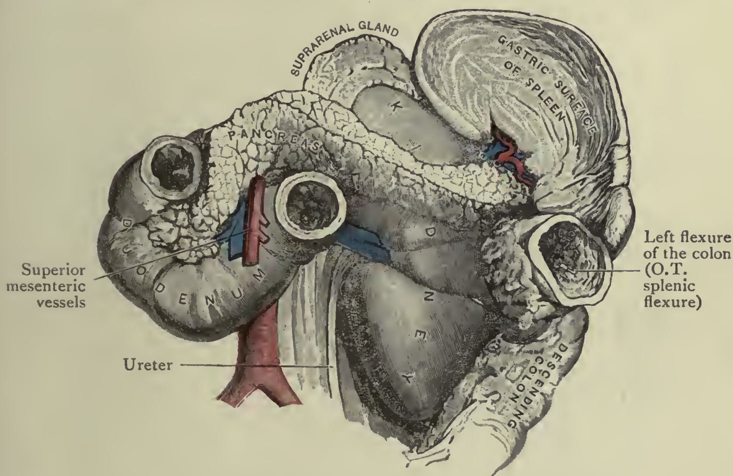


FIG. 178.—Relations of the Left Kidney and the Pancreas.

portion of the surface is covered with peritoneum of the omental bursa.

The lower part of the anterior aspect of the left kidney presents a varying relation to the intestinal canal. Towards the lateral border of the organ is the *descending colon*, whilst more medially the surface is in relation to coils of the *small intestine*.

The parts of the anterior surface of the left kidney which are directly covered with peritoneum are the parts above the pancreas in relation with the stomach and the spleen; the part below the pancreas and to the medial side of the descending colon.

Posterior Surfaces of the Kidneys.—The posterior surface of each kidney is mapped out into a medial and a lateral district. The *medial district* is the narrower of the two, and looks medially and backwards. It is in apposition with the psoas major muscle and the crus of the diaphragm, and it is separated from the lateral district by a rounded ridge, which corresponds to the angle between the planes of the psoas and quadratus lumborum muscles. The *lateral district* looks backwards. In its upper third it rests on the diaphragm, and in its lower two-thirds, upon the quadratus lumborum

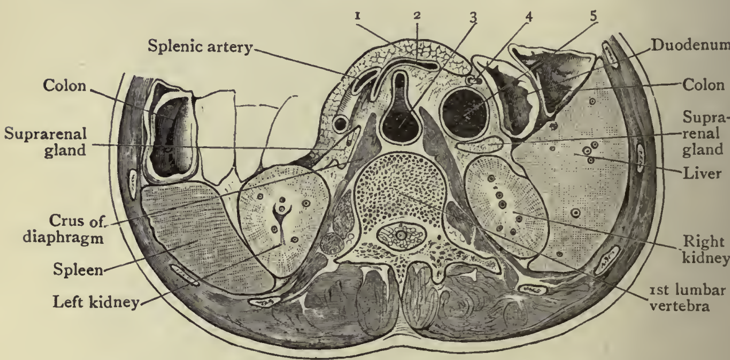


FIG. 179.—Transverse section through Abdomen at the level of the first lumbar vertebra.

1. Pancreas.
2. Splenic vein, joining the portal vein.
3. Aorta, giving off the superior mesenteric artery.
4. Rod in bile-duct.
5. Inferior vena cava.

and the aponeurosis of origin of the transversus muscle. The upper end of the kidney curves slightly forwards in correspondence with the diaphragm, on which it lies; and it should be borne in mind that between the diaphragm and the last rib the pleural cavity descends behind the kidney for a short distance (Fig. 180).

Additional posterior relations are:—the lumbo-costal arches; the last thoracic nerve and the sub-costal artery; and, at a lower level, the ilio-hypogastric nerve. The ilio-inguinal nerve may also be a posterior relation, but in many cases it lies below the level of the lower pole of the kidney.

In spare subjects, when the kidneys have been hardened *in situ*, dimples, corresponding to the tips of the transverse processes of the first, second and third lumbar vertebræ, and a shallow groove for the last rib, may sometimes be detected on the posterior surface of the kidney. A furrow corresponding to the lateral lumbo-costal arch is sometimes to be seen on the posterior aspect of the kidney.

The student should never experience any difficulty in determining the side to which a given kidney belongs. Even

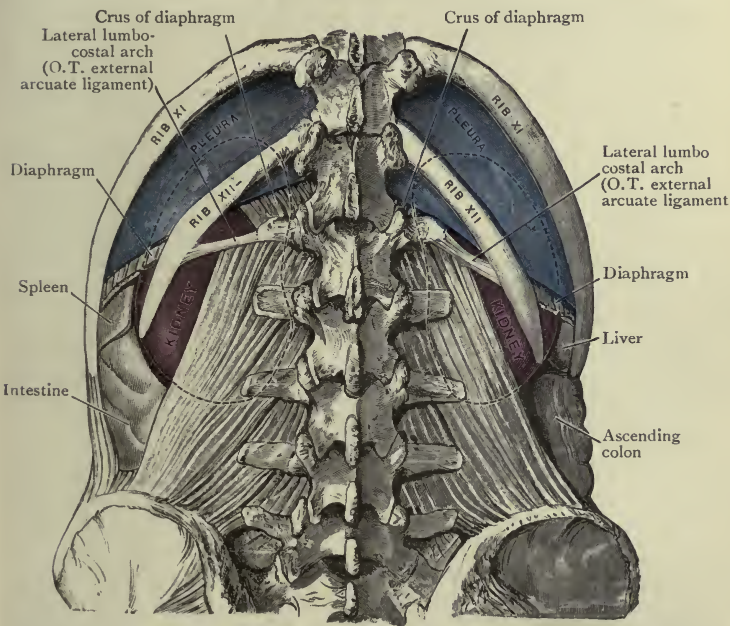


FIG. 180.—Dissection from behind to show the relation of the two Pleural Sacs to the Kidneys. Outline of upper portions of kidneys indicated by dotted lines.

allowing that the upper end cannot be distinguished from the lower end, or the anterior surface from the posterior surface, by differences in their appearance (which is frequently the case when the kidney has not been hardened *in situ*), the ureter alone is sufficient for the purpose. It lies next the posterior lip of the hilum, and it curves downwards towards the lower end of the kidney.

Kidney Capsule and Kidney Substance.—The kidney is invested by a strong fibrous capsule, which can be easily stripped from its surface. Divide the capsule along the lateral margin of the organ and peel it off towards the hilum. There it enters the renal sinus, lines the walls of the sinus, and becomes continuous with the sheaths of the vessels entering the gland, and also with the external coats of the calyces of the ureter.

Examine the manner in which the ureter or duct is connected with the kidney. As it approaches the hilum it expands into a wide funnel-shaped portion called the *pelvis* (Fig. 183).

The pelvis enters the sinus and divides into two, or perhaps three, large primary branches, and those again break up into a large number of short, stunted secondary divisions called *calyces*, which are attached to the walls of the sinus.

> ***Dissection.***—**Divide the kidney into anterior and posterior parts. Take a large knife and carry it through the kidney from the lateral border to the hilum, parallel with and midway between the two surfaces. Then examine the cut surfaces and the contents of the sinus.**

An examination of the cut surface of the kidney will show that its substance is arranged in two parts—a medullary and a cortical. The *medullary portion* consists of dark-coloured, faintly striated pyramidal masses, the bases of which are directed towards the periphery, whilst their apices are free and project into the sinus. On the sinus wall the apex of each medullary pyramid forms a prominent mamillary projection, called a *renal papilla*, which projects into one of the calyces of the pelvis of the ureter (Fig. 182). If the kidney is squeezed, fluid will be seen to exude from the papillæ, showing that the tubuli uriniferi open upon their surface. The number of pyramids and renal papillæ varies from eight to twenty. Usually there are more than twelve. A single calyx of the ureter may surround one, two, or even three renal papillæ; it receives the urine as it issues from the papillary ducts which open on their surfaces. The *cortical substance* constitutes the peripheral part of the gland, and also sends prolongations inwards between the pyramids. The prolongations of the cortex are called the *columnæ renales* (O.T. *columns of Bertin*).

Ureter.—The ureter is the duct which carries the urine from the kidney to the bladder. The relations of its expanded upper end or pelvis at the hilum of the kidney have already been noted. After leaving the gland, it turns downwards and becomes contracted, so that when it reaches the level of the lower end of the kidney it has acquired the appearance of a cylindrical tube.

Each ureter extends downwards and medially, on the anterior surface of the psoas major muscle of the same side, to the lower end of the common iliac artery, or the upper end of the external iliac artery; there it leaves the abdomen proper and enters the pelvis minor, where it will be studied at a later period. As it dips into the pelvis minor the right ureter passes behind the termination of the ileum, and the left behind the pelvic colon; and as it lies on the front of the psoas major muscle each ureter crosses obliquely in front of the genitofemoral nerve of the same side. The anterior relations of the abdominal parts of the two ureters differ slightly from each other. The right ureter commences behind the descending part of the duodenum, and crosses behind the commencement of the inferior part; both parts, therefore, separate it from the peritoneum. Below the duodenum

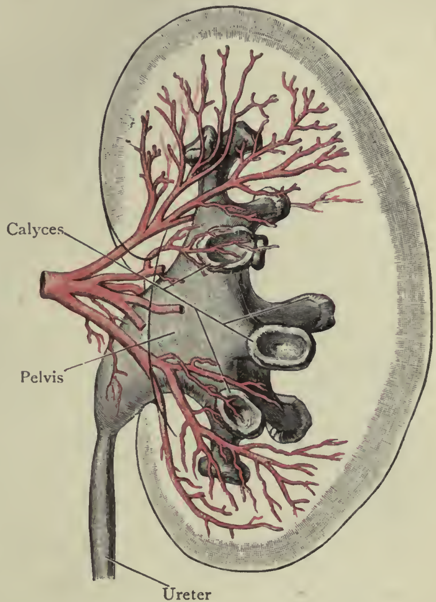


FIG. 181.—From a figure by Max Brödel to show the form of the Pelvis of the Ureter and the Calyces, as well as the relation of the main branches of the Renal Artery to these. The ureter, pelvis, calyces, and arteries were injected with celloidin, and then the kidney substance was removed by means of a digesting fluid. It is, thus, a cast of the pelvis and calyces which is represented, and the cupped appearance of each calyx shows the manner in which the corresponding renal papilla projects into the calyx.

it descends behind the peritoneum, from which it is partially separated by the right internal spermatic or ovarian vessels, the right colic and the ileo-colic vessels, and the terminal parts of the superior mesenteric artery and vein. The whole of the abdominal portion of the left ureter is in relation, in front, with the peritoneum, except that it is crossed anteriorly, behind the peritoneum, by the left internal spermatic or ovarian vessels, the left colic vessels, and the sigmoid vessels.

Dissection.—Having now studied all the viscera within the cavity of the abdomen proper, the student should, in the next place, direct his attention to the diaphragm—the great muscle which constitutes a movable partition between the thoracic and abdominal cavities. Strip the peritoneum from its lower, concave surface; clean the muscular fibres and the central tendinous expansion towards which they ascend, but be careful to preserve the inferior phrenic arteries, which ramify upon the inferior aspect of the diaphragm, and also the nerves which accompany them.

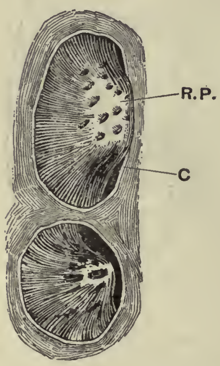


FIG. 182.—Diagram of two Renal Papillæ.

R.P. Renal papilla.

C. Cut edge of a calyx of the pelvis of the ureter.

Diaphragma.—The diaphragm, after the heart, is the most important muscle in the body. It forms the dome-shaped roof of the abdomen, and the highly arched and convex floor of the thorax. It is the chief muscle of respiration. Each respiratory act is accompanied by its descent and ascent, and in that way the capacity of the thoracic cavity is alternately increased and decreased in the vertical direction. The vault or cupola of the diaphragm is higher on the right side than on the left side of the body. In forced expiration it may rise, on the right side, as high as the upper margin of the fourth rib, in the right lateral line; whereas, on the left side, it reaches only as high as the upper border of the fifth rib (Fig. 36).

The *central portion* of the diaphragm is tendinous. From the tendon the fleshy fibres radiate, and at the same time arch downwards, to obtain attachment to the circumference of the lower aperture or outlet of the thorax. *Anteriorly*, the diaphragm takes origin from the posterior surface of the xiphoid process; *laterally*, it arises from the lower six costal

PLATE XVII

FIG. 183.—Radiograph of the Abdominal Part of the Left Ureter injected with collargol. (Frank Kidd, F.R.C.S.)

Note (1) The relation of the pelvis of the ureter to the last rib.
(2) That only relatively few calyces are shown.
(3) That the ureter does not possess the usual convex curve towards the median plane.

arches; *posteriorly*, it springs by two powerful, partly fleshy and partly tendinous processes, called *the crura*, from the bodies of the upper three lumbar vertebræ, and, on each side of those, from two ligamentous arches, termed the *lumbo-costal arches* (O.T. *ligamenta arcuata*) (Fig. 184).

Anterior Attachment.—The sternal origin consists of two fleshy slips which spring from the back of the xiphoid process. These are separated from each other by a narrow linear interval filled with areolar tissue, and comparable with the

FIG. 184.—Semi-diagrammatic View of the Attachments of the Diaphragm.

1. Sternal origin (left).
2-7. Costal origins (left).
8. Medial lumbo-costal arch (left).
9. Lateral lumbo-costal arch (left).
10. Tendinous parts of the crura (left and right).

wider interval, in the median plane behind, which separates the two crura of the diaphragm.

Lateral Attachments.—The costal origin consists of six pointed and fleshy slips which spring from the deep surfaces of the lower six costal cartilages on each side. They interdigitate with the digitations of the transversus abdominis. The sternal and costal origins of the diaphragm, on each side, are separated by a small triangular interval in which the pleural and peritoneal membranes are separated from each other merely by some loose areolar tissue. Through the gap the superior epigastric branch of the internal mammary artery descends into the abdominal wall.

Posterior Attachment.—The *lateral lumbo-costal arch* (O.T. *ligamentum arcuatum externum*) is a fibrous band which stretches from the last rib to the transverse process of the first lumbar vertebra. It arches in front of the quadratus lumborum, and is merely the thickened upper part of the fascia which covers that muscle, *i.e.*, the anterior lamella of the lumbar fascia. If the rib is pressed backwards the arch will be rendered more distinct. The last thoracic nerve passes laterally and downwards behind the *lateral lumbo-costal arch.* The *medial lumbo-costal arch* (O.T. *ligamentum arcuatum internum*) arches over the psoas major muscle, and, like the lateral arch, is simply a thickening of the fascia which covers the muscle. It is the stronger of the two arches, and is attached by one extremity to the tip of the transverse process of the first lumbar vertebra, and by the other to the body of the second lumbar vertebra and the tendinous part of the corresponding crus of the diaphragm. Fleshy fibres arise from both of the arcuate bands; those from the medial arch are more numerous and better marked than those which take origin from the lateral arch, and they are continuous with the fleshy fibres of the crus. Very frequently a gap or interval exists between the fibres which spring from the lateral arch and those which arise directly from the last rib. The anterior, lateral, and posterior attachments of the diaphragm are therefore marked off by intervals from each other.

The *crura* of the diaphragm are two thick fleshy processes which descend upon the bodies of the upper lumbar vertebræ, tapering as they proceed downwards. They end in pointed tendinous extremities. The *right crus* is the larger and longer of the two. It takes origin to the right of the median plane from the bodies of the upper three lumbar vertebræ, and the intervertebral fibro-cartilages between them. The *left crus* is attached, on the left of the median plane, to the bodies of the first two lumbar vertebræ and the intervening fibro-cartilage. It is much smaller than the right crus. Follow the crura upwards; opposite the last thoracic vertebra they are connected across the middle line by a strong fibrous band which arches over the aorta. From the upper border of that fibrous arch fleshy fibres arise which join both crura; and on that account the arch is called the *ligamentum arcuatum medium.*

It may be regarded as a law that wherever an artery pierces the origin or insertion of a muscle, and comes to lie between bone and muscular fibres, it is protected by a fibrous arch. Of this nature is the arch in question, and also the fibrous arch thrown over the profunda artery on the back of the humerus, and the fibrous arches in the adductor magnus for the passage of the perforating arteries, and of the femoral artery itself.

Above the level of the ligamentum arcuatum medium the fleshy fibres of the crura diverge and ascend to join the posterior border of the central tendon. The most medial fibres of each crus, however, decussate so as to separate the aortic from the œsophageal openings. The decussating fasciculus of the right crus is always the larger of the two, and, moreover, it frequently passes behind the decussating fasciculus of the left crus, but may pass in front of it (Fig. 184).

It is the custom of some authors to divide each crus into three parts, a lateral crus, an intermediate crus, and a medial crus. The lateral crus is formed by the fibres which spring from the medial lumbo-costal arch. It is separated from the intermediate crus by the sympathetic trunk. The intermediate crus is separated from the medial crus by the splanchnic nerves. In many cases, however, the subdivisions are not distinct.

Centrum Tendineum.—The central tendon of the diaphragm is exceedingly strong. It is composed of tendinous bundles running in different directions, and closely woven together in such a manner as to give it a plaited appearance. The appearance is well seen from the abdominal surface. The central tendon is somewhat semilunar in outline, with a broader and shorter right and a narrower and longer left horn. Upon all sides it is surrounded by muscular fibres of which those attached to the sternum are much the shortest.

Foramina of the Diaphragm.—The continuity of the diaphragm is broken by *three* large openings, and by some smaller apertures or fissures for the passage of the splanchnic nerves, and the vena hemiazygos. The three main openings receive the names of the most important objects which they transmit. They are—

1. The aortic.
2. The vena caval.
3. The œsophageal.

Hiatus Aorticus.—The aortic opening is in the median plane, in front of the first lumbar vertebra, and between the crura of the diaphragm. It is bounded in front by the fibrous middle arcuate ligament, which arches across the median plane and connects the tendinous portions of the two crura. The structures which pass through the aortic opening are—(1) the

II—25 *a*

aorta, (2) the thoracic duct, and (3) the vena azygos—in that order from left to right.

Foramen Venæ Cavæ.—The vena caval opening is at a higher level, being situated opposite the fibro-cartilage between the eighth and the ninth thoracic vertebræ, in front and slightly to the right of the aortic opening. It is placed in the posterior part of the central tendon at the junction between its middle and the right horn. Its form is somewhat quadrangular, and its margins are prolonged upon the walls of the vena cava as that vessel passes through it. The contraction of the muscular fibres of the diaphragm will therefore tend to increase the size of the opening and the calibre of the vein which it holds.

In addition to the vena cava, one or two minute twigs from the right phrenic nerve may be transmitted through the vena caval opening.

Hiatus Œsophageus.—The œsophageal opening is an oval or elliptical foramen in the muscular part of the diaphragm. It lies in front and slightly to the left of the aortic aperture, and also at a higher level, being placed opposite the tenth thoracic vertebra. In a few cases its upper or anterior border is tendinous, being formed by the posterior margin of the central tendon. Posteriorly, it is separated from the aortic opening by the decussation of the medial fibres of the crura.

The œsophageal opening transmits the œsophagus, the two vagi nerves, and some œsophageal vessels.

The three large openings of the diaphragm, therefore, present very different features. The *aortic opening* is bounded by a fibrous arch behind the diaphragm, and it can in no way be affected by the contraction of the muscular fibres. The *vena caval opening* is in the central tendon, and its margins are attached to the wall of the vessel which it transmits; contraction of the diaphragm must therefore have a tendency to open this aperture to its widest extent. The *œsophageal opening* is placed in the muscular part, and consequently it is probable that the fibres which surround it are capable of exercising a constricting influence upon the œsophagus, and in that way help to prevent regurgitation of food during the descent of the diaphragm.

Little need be said regarding the smaller foramina. Each crus is pierced by the *three splanchnic nerves*, and the left crus is perforated, in addition, by the *hemiazygos vein*. The *superior epigastric artery* descends in the interval between the sternal and costal attachments of the diaphragm; and the *musculo-phrenic artery* passes between two slips of the costal attachment opposite the eighth or ninth rib.

Vessels on the Posterior Wall of the Abdomen.

Dissection.—The abdominal part of the aorta and its branches and the inferior vena cava must now be cleaned. As the dissection proceeds the dissector must take care to secure the gangliated trunks of the sympathetic, which extend downwards, on the vertebral column, along the anterior borders of the psoas major muscles. It is necessary to bear in mind that the lumbar branches of the aorta, as they proceed laterally, pass behind the sympathetic trunks. Separate the right crus of the diaphragm from the aorta, and dissect in the interval between them. There the cisterna chyli and the vena azygos will be found. A chain of lymph glands, termed the lumbar glands, will be noticed in relation to the aorta. The only branches of the aorta which are liable to injury are the internal spermatic arteries. They are two slender arteries which spring from the front of the aorta, a short distance below the renal arteries. They are so small that they are apt to be overlooked.

Aorta Descendens, pars Abdominalis. — The abdominal part of the aorta is the direct continuation of the thoracic part. It begins in the median plane, in the upper part of the aortic orifice of the diaphragm, in front of the lower border of the last thoracic vertebra; and it ends in front of the lower part of the body of the fourth lumbar vertebra, a little to the left of the median plane, by dividing into the two *common iliac arteries*. It therefore pursues an oblique course—inclining slightly to the left as it proceeds downwards. A line drawn between the highest points of the iliac crests would indicate the level of the bifurcation of the abdominal aorta, which takes place a little below and to the left of the umbilicus.

Most of the structures which lie *in front of* the abdominal aorta have been removed. In immediate relation to it from above downwards are:—(1) The cœliac plexus and the layer of peritoneum which forms the posterior wall of the omental bursa. (2) The pancreas and splenic vein. (3) The left renal vein and the third part of the duodenum. (4) The root of the mesentery and the superior mesenteric vessels. (5) The peritoneum and the aortic plexus of nerves. More superficially it is covered by the lesser omentum; the liver; the stomach; the transverse colon and its mesentery; and by the great omentum and the coils of the small intestine. *Behind*, the abdominal aorta rests upon the bodies of the lumbar vertebræ and the intervertebral fibro-cartilages, separated from them, however, by the anterior longitudinal ligament and the left lumbar veins. *On each side*, it is related, in its upper part, to the crus of the diaphragm. *On the right side*, the inferior vena cava lies close to the aorta, as high as the second lumbar vertebra, but above that it is separated from the aorta by the fleshy part of the right crus. In the interval between the right crus of the diaphragm and the aorta, the dissector has already noted the cisterna chyli and the vena azygos. *On each side*, the gangliated trunk of the sympathetic is in relation to the artery, below the level of the crura of the diaphragm.

Branches of the Abdominal Aorta.—The branches of the abdominal aorta may be described under two heads, viz.—(1) Those which come off *in pairs*. (2) Those which arise *singly*.

Paired Branches.	Single Branches.
1. A. phrenica inferior.	1. A. cœliaca.
2. A. suprarenalis media.	2. A. mesenterica superior.
3. A. renalis.	3. A. mesenterica inferior.
4. A. spermatica interna.	4. A. sacralis media.
5. Aa. lumbales.	

With the exception of the *middle sacral*, which arises from the back of the extremity of the aorta, between the two common iliacs, the *single branches* have already been described. The middle sacral artery will be examined when the pelvis minor is dissected. The *paired branches* may now be examined.

The Inferior Phrenic Arteries have already been noticed upon the under surface of the diaphragm. They are two in number, and are the first branches which spring from the abdominal aorta. As they pass upwards and forwards they diverge from each other, the artery of the right side passes behind the inferior vena cava, whilst the artery of the left side goes behind the œsophagus. Near the posterior border of the central tendon of the diaphragm each divides into a lateral and a medial branch. The *lateral branch* proceeds laterally to anastomose with the intercostal arteries, whilst the *medial branch* curves forwards to the front of the central tendon, and ends by anastomosing with its fellow and with the terminal branches of the internal mammary artery. Each inferior phrenic artery, in addition to the branches which it supplies to the diaphragm, gives a twig, called the *superior suprarenal artery*, to the suprarenal gland. The left artery sends a few minute branches to the œsophagus also.

The *inferior phrenic veins* open into the inferior vena cava.

The Middle Suprarenal Arteries (O.T. **Middle Capsular Arteries**) are two small vessels which arise, one from each side of the aorta, at the same level as the superior mesenteric. Each runs laterally and upwards, in front of a crus of the diaphragm, to the suprarenal gland, into the substance of which it sinks. The right middle suprarenal artery passes behind the inferior vena cava. They anastomose freely with the superior and inferior suprarenal arteries.

The *right suprarenal vein* opens into the inferior vena cava, whilst the *left suprarenal vein* ends in the left renal vein or in the left inferior phrenic vein.

The Renal Arteries.—When compared with the organs which they supply, the renal arteries are disproportionately large. Only a small part of the blood which they carry to the kidneys is used for the nourishment of the gland substance. The kidneys are excretory organs, and it is necessary that the blood should pass to them in large quantity in order that certain materials may be removed from it.

The renal arteries take origin, about a quarter of an inch below the superior mesenteric, at the level of the second lumbar vertebra. Each artery proceeds laterally, at right angles to the aorta, and, approaching the kidney, breaks up into three branches, which enter the hilum, and pass deeply into the renal sinus. Each artery is overlapped by the accompanying vein. The right artery is placed at a slightly lower level than the left, and passes behind the inferior vena cava. At the hilum two of the terminal branches, as a rule, lie between the renal vein and the pelvis of the ureter, whilst the third enters the sinus behind the pelvis of the ureter. In the renal sinus the three terminal branches break up into numerous smaller branches, which penetrate the kidney substance in the intervals between the renal papillæ (Fig. 181, p. 383).

The renal artery gives a small branch—the *inferior suprarenal*

—to the suprarenal gland, and also numerous fine twigs to the connective tissue around the kidney, and to the upper part of the ureter.

The *renal veins* join the inferior vena cava. The vein of the left side is the longer of the two. It lies behind the pancreas and crosses in front of the aorta immediately below the root of the superior mesenteric artery. It receives a tributary from the left suprarenal gland; it is joined also by the left internal spermatic or ovarian vein.

The Internal Spermatic Arteries are two long slender vessels which spring from the front of the abdominal aorta, a short way below the renal arteries. Diverging from its fellow, each artery passes obliquely downwards and laterally, behind the peritoneum, to the abdominal inguinal ring, where it joins the other factors of the spermatic cord. As it descends it rests upon the psoas major, and crosses anterior to the ureter and the lower end of the external iliac artery. On the right side the internal spermatic artery passes in front of the vena cava inferior and behind the terminal part of the ileum. On the left side it proceeds downwards behind the iliac colon (Fig. 156).

In the female the corresponding arteries go to the ovaries, and are consequently termed the *ovarian arteries*. Within the abdomen proper they have the same relations as the spermatic arteries, except that they cross the upper ends of the external iliac arteries. In the dissection of the female pelvis minor they will be followed to their destination.

The *right internal spermatic vein* joins the inferior vena cava directly, whilst the *left vein* terminates in the left renal vein. The *ovarian veins* end in the same manner.

The Lumbar Arteries are four in number on each side, and they spring from the posterior aspect of the abdominal aorta, in series with the intercostal arteries. At present only portions of them are visible. They proceed laterally upon the bodies of the upper four lumbar vertebræ, behind the gangliated trunk of the sympathetic, and then disappear under cover of the psoas major muscle and of the series of fibrous arches from which the muscle arises. The upper two arteries pass behind the crura of the diaphragm also, and on the right side all pass behind the inferior vena cava.

The *lumbar veins* join the inferior vena cava, those of the left side passing behind the aorta on their way to their terminations.

Vena Cava Inferior.—The inferior vena cava is the large vein which collects, by means of its tributaries, the venous blood from the lower limbs, the abdominal viscera, and a

FIG. 185.—Sagittal section of the upper part of the Abdomen and the lower part of the Thorax of a Young Male Adult along the line of the Inferior Vena Cava.

D-D, Plan of Section shown in Fig. 21.

Note that the foramen epiploicum lies between the inferior vena cava, which is behind it, and the portal vein, which is in front of it.

great part of the abdominal parietes. It is formed by the union of the two *common iliac veins*, to the right of the median plane in front of the fifth lumbar vertebra and behind the right common iliac artery (Fig. 185). As it ascends it lies at first at the right side of the aorta, in front of the bodies of the vertebræ and the medial part of the right psoas major, but it is separated from the vertebral bodies by the anterior longitudinal ligament and the lower right lumbar arteries, and from the anterior border of the psoas major by the right sympathetic trunk. Above the lower border of the second lumbar vertebra it is separated from the aorta by the right crus of the diaphragm. The right renal artery, the right cœliac ganglion, the right suprarenal artery, the right inferior phrenic artery, and the medial part of the anterior surface of the right suprarenal gland intervene between it and the right crus. At its commencement it lies behind the right common iliac artery; then it is crossed by the root of the mesentery and the superior mesenteric vessels. For a short distance above the root of the mesentery it is in direct relation with the peritoneum. At the level of the third lumbar vertebra it is crossed by the inferior part of the duodenum and the right internal spermatic or ovarian artery. Next, the head of the pancreas and the pancreatico-duodenal arteries are in front of it, and the bile-duct descends in front of its lateral border. Above the head of the pancreas it passes behind the first part of the duodenum, from which it is separated by the portal vein; then it ascends behind the epiploic foramen; and, finally, it lies in the vena caval fossa on the posterior surface of the liver, and the hepatic veins open into the uppermost part of it anteriorly.

It receives the following tributaries :—

1. The common iliac veins.
2. The lumbar veins.
3. The right internal spermatic or ovarian vein.
4. The renal veins.
5. The right suprarenal vein.
6. The inferior phrenic veins.
7. The hepatic veins.

Arteriæ Iliacæ Communes.—The two common iliac arteries, which are the terminal branches of the aorta, should next be examined. They arise upon the front of the body of the fourth lumbar vertebra, to the left of the median plane, and, diverging from each other, proceed downwards and laterally upon the vertebral column. After a course of about 50 mm. (two inches), each vessel ends opposite the corresponding sacro-iliac articulation, at the level of the lumbo-sacral articulation, by dividing into an *external iliac* and a *hypogastric* (O.T. *internal iliac*) branch; the external iliac is the larger of the two branches, and appears to be the continuation of the parent trunk, whilst the hypogastric artery, which was the original continuation, passes downwards and backwards into the pelvis minor.

The common iliac artery of each side is covered by peritoneum, and overlapped by coils of the small intestine; furthermore, it is crossed by the large sympathetic twigs which connect the aortic and hypogastric plexuses, and, close to its termination, by the ureter. On the left side the superior hæmorrhoidal vessels also pass in front of the common iliac artery medial to the ureter.

The left common iliac artery is in relation posteriorly with the bodies of the last two lumbar vertebræ, the left sympathetic trunk and the medial margin of the left psoas major muscle. The right artery is separated from the vertebræ and the sympathetic trunk by the two common iliac veins and the commencement of the inferior vena cava.

No collateral branches of any consequence proceed from the common iliac arteries.

Venæ Iliacæ Communes.—Each of the two common iliac veins is formed by the junction of the external iliac and hypogastric veins of the corresponding side, the junction taking place behind the upper end of the hypogastric artery. The *left common iliac vein* is much longer than the right, and stands in relation to both common iliac arteries. It first lies along the *medial* or *right* side of its companion artery, and on a posterior plane; then it passes *behind* the upper part of the right artery to reach the vena cava inferior. The *right common iliac vein* lies *behind* its companion artery, and behind the upper part of the artery it joins with the left vein to form the inferior vena cava.

Tributaries.—In addition to the external iliac and hypogastric veins, by the union of which it is formed, the common iliac vein of each side is joined by an *ilio-lumbar vein.* The left common iliac vein receives, in addition, the *middle sacral vein.*

Arteriæ Iliacæ Externæ.—Each external iliac artery is the first or abdominal portion of the great arterial trunk which carries blood to the lower limb. It begins opposite the corresponding sacro-iliac articulation, at the level of the lumbo-sacral articulation, and extends obliquely downwards and laterally, along the brim of the pelvis minor, to the inguinal ligament, behind which it passes into the thigh, and becomes the *femoral artery.* Its course is indicated on the surface by the lower two-thirds of a line drawn from a point a little below and to the left side of the umbilicus to a point midway between the symphysis pubis and the anterior superior spine

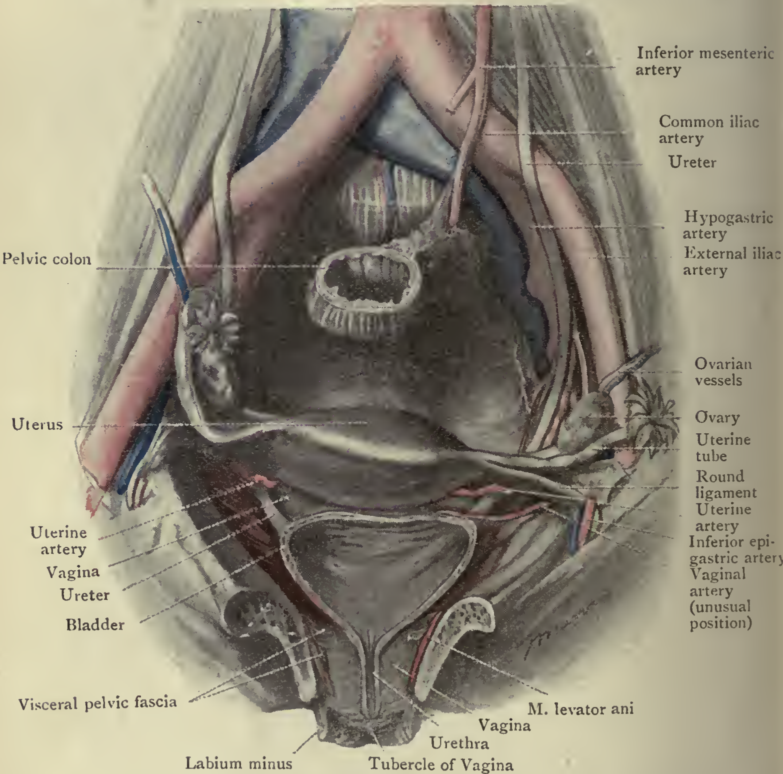


FIG. 186.—Dissection of the Pelvis of a multiparous female, showing the relations of the Bladder to the Uterus and Vagina, the relations of the Vagina to the Urethra and Broad Ligaments, and the relations of the Ureters to the Broad Ligaments and Vagina.

of the ilium. The upper third of the line indicates the position of the common iliac artery.

The external iliac, like the common iliac artery, is in close relation with the peritoneum which covers it anteriorly and medially. The right artery passes behind the terminal part of the ileum, and the left passes behind the pelvic colon.

Towards its termination each external iliac artery is crossed by the deep circumflex iliac vein, and the external spermatic nerve (O.T. genital branch of genito-crural). In the male, the terminal part of the artery is crossed also by the ductus deferens and the internal spermatic vessels, and in the female, by the round ligament of the uterus. At first the external iliac artery rests upon the medial margin of the psoas major muscle, but close to the inguinal ligament it comes to lie directly in front of that muscle. The artery is separated from the muscle, however, by the fascia iliaca, to which it is bound down by a condensed part of the extra-peritoneal tissue. The genito-femoral nerve lies along the lateral side of the artery, and the external iliac vein is placed on its medial side, on a posterior plane; on the right side, however, the vein, as it passes upwards, gradually comes to lie behind the artery.

Branches.—Each external iliac artery gives off two large branches to the abdominal wall, viz.—(1) the inferior epigastric; (2) the deep circumflex iliac. They arise close to the inguinal ligament, and have both been examined (pp. 228, 229). The corresponding veins open into the external iliac vein.

Venæ Iliacæ Externæ.—The external iliac veins are the continuations of the femoral veins. Each external iliac vein commences, therefore, at the upper border of the inguinal ligament, where the femoral vein terminates. As it ascends in the abdomen it lies along the brim of the pelvis minor, on the medial side of the corresponding external iliac artery, but on a more posterior plane. Just before it terminates, by joining the hypogastric vein to form the common iliac vein, it passes lateral to the upper end of the hypogastric artery, and between that artery and the medial border of the psoas major muscle.

Tributaries.—Each external iliac vein receives two tributaries, which are the inferior epigastric and the deep circumflex iliac veins of the same side.

Deep Lymph Glands.—The dissector has, doubtless, noticed a chain of lymph glands in connection with the external iliac artery, the common iliac artery, and also extending upwards upon the vertebral column in relation to the aorta and inferior vena cava. The *external iliac glands* are in two groups—a lower and an upper. The former consists of three glands placed one on each side and one in front of the external iliac artery, and immediately above the inguinal ligament. The medial gland receives the deep femoral lymph vessels; into the anterior gland is poured the lymph which is drained from the district supplied by the inferior epigastric artery; whilst the lateral gland receives the lymph from the district supplied by the deep circumflex iliac artery. The efferent vessels from the lower group enter the higher group of glands, and from those the lymph is passed on to the common iliac and lumbar glands.

The common iliac glands lie alongside the common iliac arteries. They receive the efferents of the external iliac and hypogastric glands, and their own efferents pass to the lumbar lymph glands.

The glands in relation to each side of the aorta and inferior vena cava are both numerous and large, and are called the *lumbar lymph glands*. Their efferent vessels terminate in two common lumbar lymph trunks, which open into the cisterna chyli.

Cisterna Chyli (O.T. **Receptaculum Chyli**).—The cisterna chyli is the dilated commencement of the thoracic duct. It is placed upon the bodies of the first and second lumbar vertebræ, in the interval between the right crus of the diaphragm and the aorta. To bring it into view, it is necessary to separate the right crus from the lumbar vertebræ and pull it aside. When fully displayed, the cisterna chyli is seen to be a narrow elongated sac, about two inches in length, which receives at its lower end the two common lumbar lymph trunks, whilst, superiorly, it contracts and becomes the thoracic duct. About its middle it is joined, anteriorly, by the intestinal lymph trunk. Entering it near its upper end are two lymph trunks which carry lymph from the lower intercostal glands; they reach it by passing downwards through the aortic opening. The vena azygos lies along its right side, but the cisterna chyli is easily distinguished from the vein by the whiteness of its walls. The thoracic duct enters the thorax by passing through the aortic opening of the diaphragm.

Vena Azygos.—The *azygos vein* (O.T. *vena azygos major*) takes origin as the continuation of the right ascending lumbar vein (p. 408), or from the back of the inferior vena cava. It will be found in the interval between the right crus of the diaphragm and the aorta, upon the right side of the cisterna chyli. It enters the thorax by passing through the aortic opening of the diaphragm.

Vena Hemiazygos (O.T. **Vena Azygos Minor Inferior**).—The *hemiazygos vein* is more difficult to discover. It originates on the left side of the vertebral column, usually as the continuation of the left ascending lumbar vein, but, occasionally, it springs from the left renal vein. It enters the posterior mediastinum of the thorax after piercing the left crus of the diaphragm.

Fascia and Muscles on the Posterior Wall of the Abdomen.

The muscles on the posterior wall of the abdomen on each side are three in number, viz.—(1) the *psoas major*, an elongated fleshy mass which lies on the side of the vertebral column; (2) the *quadratus lumborum*, a quadrate muscle lateral to the psoas, and extending from the crest of the ilium to the last rib; (3) the *iliacus*, situated in the iliac fossa. The fascia which covers the muscles must be studied first.

Quadratus Lumborum Fascia.—When the fascia which covers the anterior surface of the quadratus lumborum muscle is followed medially it will be found to be attached to the medial ends of the anterior surfaces of the transverse processes of the lumbar vertebræ. Traced laterally it will be found to join the posterior aponeurosis of the transversus abdominis muscle. The dissector will understand, from the connections of the fascia, that it is simply the anterior lamella of the lumbar fascia. Above, it is fixed to the last rib, and is thickened to form the *lateral lumbo-costal arch*, whilst inferiorly it blends with the ilio-lumbar ligament. The quadratus lumborum muscle, therefore, is enclosed in a sheath formed anteriorly by the anterior lamella of the lumbar fascia, and posteriorly by the middle lamella of the lumbar fascia (Fig. 114, p. 249).

Fascia covering the Psoas and Iliacus.—One continuous membranous sheet of fascia covers the anterior surfaces of the psoas and iliacus muscles on each side. *Above* the level of the crest of the ilium, where it is in relation only to the psoas, it is thin and narrow. There it is attached laterally to the fascia covering the quadratus lumborum, whilst medially it is fixed to the vertebral column by a series of fibrous arches which bridge over the lumbar arteries. Superiorly, it thickened to form the band termed the medial lumbo-costal arch. *Inferiorly*, the fascia expands so as to cover both the psoas and the iliacus; at the same time it becomes much denser and thicker and is called the *fascia iliaca.* The fascia iliaca has important connections and relations. The external iliac vessels lie upon it, whilst the femoral nerve lies behind it. The genito-femoral nerve pierces it, and comes into relation with the external iliac artery. Laterally, it is firmly fixed to the crest of the ilium; medially, it sweeps over the psoas, and is attached to the brim of the pelvis minor. The attachments mentioned can be easily demonstrated if the fascia is divided in the vertical direction, over the iliacus, a short way to the lateral side of the psoas, and is then reflected medially and laterally. It is very loosely attached to the subjacent muscles, so that the fingers can readily be passed behind it, first in a lateral and then in a medial direction. Note that no perceptible fascial partition dips backwards from it between the psoas and iliacus.

The inferior connections of this fascia have already been studied (Vol. I., p. 240). On the lateral side of the iliac vessels it has been seen to become continuous with the fascia transversalis, and, at the same time, to be attached to the inguinal ligament; whilst behind the femoral vessels it is carried downwards into the thigh, to form the posterior wall of the femoral sheath.

Surgical Anatomy.—The attachments of the ilio-psoas fascia are of high surgical importance. When an abscess forms in connection with the lumbar vertebræ the pus readily passes downwards within the psoas sheath, and in certain cases is conducted behind the inguinal ligament so as to point in the thigh. It cannot enter the pelvis minor owing to the attachment of the fascia iliaca to the ilio-pectineal line.

Dissection.—**The muscles should now be cleaned and their attachments defined; but, while that is being done, certain points must be attended to. The medial portion of the fascia iliaca must be preserved, in order that its relation to the pelvic fascia may be afterwards made out. In the case of the psoas major muscle, care must be taken not to injure—(1) the sympathetic trunk, which lies along its anterior margin; (2) the genito-femoral nerve, which runs downwards on its anterior surface; (3) the ilio-inguinal nerve, and the lateral cutaneous nerve of the thigh, which appear at its lateral border; and (4) the femoral nerve, which lies in the interval between it and the iliacus muscle. In the case of the quadratus lumborum, bear in mind that the**

last thoracic nerve runs laterally in front of that muscle, close to the lower border of the last rib, and that the ilio-hypogastric and ilio-inguinal nerves cross it obliquely at a lower level.

M. Quadratus Lumborum.— The quadratus lumborum muscle *arises* from the ilio-lumbar ligament and from the crest of the ilium behind that ligament. It receives two or three slips also from the transverse processes of a corresponding number of the lower lumbar vertebræ. As it passes upwards it narrows slightly, and it is *inserted* into the medial half of the last rib behind the lateral lumbo-costal arch, and by four tendinous slips into the tips of the transverse processes of the upper four lumbar vertebræ. It is supplied by the anterior rami of the upper four lumbar nerves. It is a lateral flexor of the vertebral column, and acting with its fellow of the opposite side it is a muscle of inspiration, for it helps to fix the lower ribs and so converts them into fixed points from which the diaphragm can act.

M. Psoas Major.—The psoas major muscle has three distinct series of origins from the corresponding side of the vertebral column. It arises:—(1) by five fleshy processes from the anterior surfaces and lower borders of the transverse processes of the lumbar vertebræ, close to their roots; (2) by five slips, each of which arises from the intervertebral fibro-cartilage and the contiguous margins of the bodies of two vertebræ—the first slip springing from the last thoracic and the first lumbar vertebræ and the intervening fibro-cartilage, and the last slip from the lower two lumbar vertebræ and the intervening fibro-cartilage; (3) from the tendinous arches which bridge over the lumbar arteries and protect those vessels from the pressure of the contracting muscle.

The psoas major tapers somewhat as it extends downwards along the brim of the pelvis minor, and a tendon appears on its lateral border, which affords attachment to the fibres of the iliacus. Passing behind the inguinal ligament, it is inserted into the lesser trochanter of the femur.

It is supplied by the anterior rami of the second, third, and fourth lumbar nerves.

Another muscle, called the *psoas minor*, is occasionally present. It springs from the bodies of the last thoracic and first lumbar vertebræ, and the intervertebral fibro-cartilage between them, and, stretching downwards upon the anterior and medial aspect of the psoas major, it ends in a tendon which is inserted into the ilio-pectineal eminence and ilio-pectineal line.

M. Iliacus.—The iliacus muscle arises from the upper part of the iliac fossa, the anterior sacro-iliac ligament, and the base of the sacrum. It is inserted into the tendon of the psoas major. Some of its fibres, however, have a separate insertion into an impression below the lesser trochanter of the femur.

It is supplied by a branch of the femoral nerve; together with the psoas major, it acts as a flexor and medial rotator of the femur until the hip-joint is flexed, and then the two muscles rotate the femur laterally.

Nerves on the Posterior Wall of the Abdomen.

The nerves on the posterior wall of the abdomen are the gangliated trunk of the sympathetic and the anterior rami of the spinal nerves, with the branches which proceed from them. These should now be dissected.

> ***Dissection.***—**Clean the sympathetic trunks, one on each side. They will be found along the anterior borders of the psoas major muscles. On their lateral sides secure the branches which connect their ganglia with the lumbar nerves, and on their medial sides the branches they give to the aortic and hypogastric plexuses. On the right side the inferior vena cava must be displaced laterally to expose the right sympathetic trunk.**

Truncus Sympathicus.—On each side, the sympathetic trunk enters the abdomen behind the medial lumbo-costal arch, and extends downwards upon the bodies of the lumbar vertebræ along the anterior border of the psoas major muscle. *Superiorly*, it is continuous with the thoracic portion of the trunk, whilst *inferiorly*, it passes behind the common iliac artery and enters the pelvis minor. In the thorax, it is placed upon the heads of the ribs; in the abdomen it lies nearer the median plane, being carried forwards by the psoas major muscle. On the right side it is covered by the inferior vena cava, and on both sides the lumbar vessels pass behind it. As a general rule, a small oval ganglion is formed upon it opposite the body of each lumbar vertebra. *Rami communicantes* and *peripheral branches of distribution* proceed from the gangliated trunk.

The *rami communicantes* connect the ganglia with the anterior rami of the lumbar spinal nerves. One or more will be found accompanying each lumbar artery. Trace them backwards by cutting through the fibrous arches which bridge over the arteries and scraping away the fibres of the psoas muscle. They join the lumbar nerves close to the intervertebral foramina.

The rami communicantes consist of two sets, viz., white and grey. The *white rami communicantes* are composed of medullated fibres which pass from the spinal nerves to the gangliated trunk. In the lumbar region there are only two or at most three white rami, and they proceed from the upper two or three lumbar nerves. The *grey rami communicantes* are much more numerous, and are formed of fibres which stream out in an irregular manner from the sympathetic trunk to the anterior rami of all the lumbar nerves.

The *peripheral branches of distribution* consist of a large number of small filaments which arise irregularly from the lumbar gangliated trunk, and pass medially, mainly to the aortic plexus, but some of the lower twigs go to the hypogastric plexus.

Dissection.—To bring the anterior rami of the lumbar nerves into view, scrape away the remains of the psoas major muscle, which was partially destroyed when the connecting sympathetic twigs were followed backwards. An occasional branch, the *accessory obturator nerve*, is liable to injury unless it is secured at once. When present, it will be found descending along the medial border of the psoas major.

Lumbar Nerves.—The anterior rami of the lumbar nerves are five in number, they pass laterally through the substance of the psoas major muscle. They increase in size from above downwards, and each nerve is connected by one or more twigs to the sympathetic trunk. Branches are given by the upper four nerves to the quadratus lumborum and by the second, third, and fourth to the psoas major.

The first *three* lumbar nerves, with a part of the *fourth*, unite in a loop-like manner to form the *lumbar plexus*, whilst the remaining part of the *fourth* joins the *fifth* to form the *lumbo-sacral trunk*. The fourth lumbar nerve is frequently called the *nervus furcalis*, because it divides to take part in the formation of both the lumbar and sacral plexuses.

Plexus Lumbalis.—The lumbar plexus is placed in front of the transverse processes of the lumbar vertebræ, in the substance of the psoas major. *Superiorly*, it is usually connected with the last thoracic nerve by a small twig which descends, in the substance of the psoas, to the first lumbar nerve ; *inferiorly*, it is brought into communication with the sacral plexus by the branch of the fourth nerve which enters into the formation of the lumbo-sacral trunk.

The following are the branches which proceed from the lumbar plexus :—

1. N. ilio-hypogastricus, } derived from 1st lumbar nerve.
2. N. ilio-inguinalis, }
3. N. genito-femoralis, ,, 1st and 2nd lumbar nerves.
4. N. cutaneus femoris lateralis, ,, 2nd and 3rd lumbar nerves.
5. N. obturatorius, ,, 2nd, 3rd and 4th lumbar nerves.
6. N. femoralis, ,, 2nd, 3rd and 4th lumbar nerves.
7. Rami musculares to the quadratus lumborum and psoas major muscles; these branches arise somewhat irregularly.

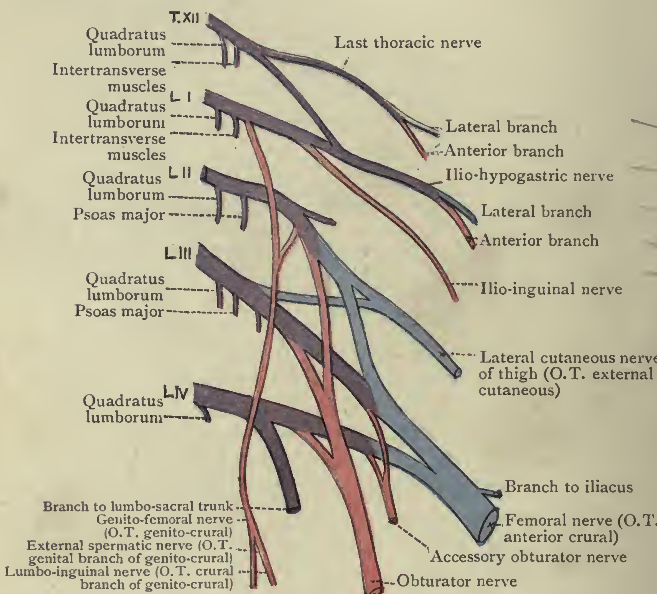


FIG. 187.—Diagram of Lumbar Plexus.

The manner in which the nerves spring from the plexus may now be studied. The *first lumbar trunk* breaks up into three branches, viz., the ilio-hypogastric, the ilio-inguinal, and the upper root of the genito-femoral. The *second*, *third*, and *fourth lumbar trunks* each divide into an anterior and a posterior division. The three anterior divisions are smaller than the posterior, and they unite to form the obturator nerve; the three large posterior divisions unite to form the femoral nerve. But other branches come off from certain of the divisions. Thus, the lower root of the genito-femoral springs from the anterior division of the second lumbar nerve, whilst the two roots of the lateral cutaneous nerve of the thigh take origin from the posterior divisions of the second and third lumbar trunks.

The *ilio-hypogastric nerve* emerges from the lateral border of the psoas, and crosses the quadratus lumborum obliquely. At the crest of the ilium, it leaves the abdomen by piercing the transversus abdominis muscle. Its further course has already

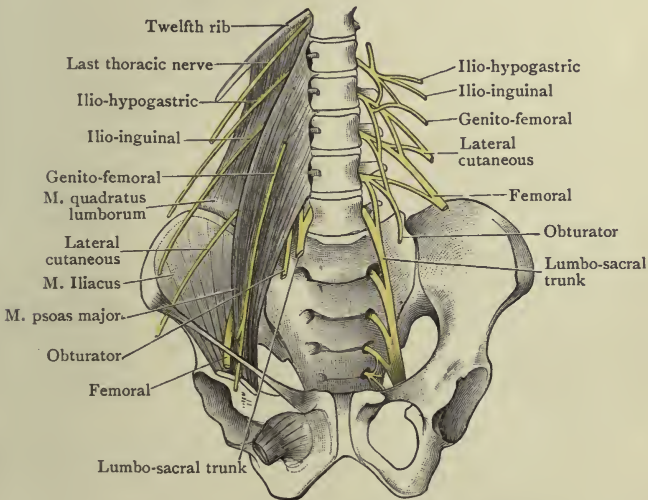


FIG. 188.—The Lumbar Plexus (semi-diagrammatic).

been studied (p. 217). It gives off a *lateral cutaneous branch* to the skin of the gluteal region, and an *anterior cutaneous branch* to the skin over the lower part of the abdominal wall.

The *ilio-inguinal nerve* leaves the psoas major immediately below the ilio-hypogastric nerve. It runs obliquely downwards and laterally over the quadratus lumborum and the upper part of the iliacus, and disappears from view by piercing the transversus abdominis muscle, a short distance anterior to the point where the ilio-hypogastric pierces that muscle. It is distributed to the integument of the scrotum in the male, and the labium majus in the female, and to the skin of the medial aspect of the proximal part of the thigh (pp. 217 and Vol. I., p. 231).

The *genito-femoral nerve* (O.T. *genito-crural nerve*) is directed forwards through the psoas major, and appears upon its anterior aspect, where it ends by dividing into a lumbo-inguinal and an external spermatic branch. The *external spermatic branch* proceeds downwards and medially. It crosses the lower end of the external iliac artery obliquely, and reaches the abdominal inguinal ring. There it comes into relation with the constituents of the spermatic cord, and, leaving the abdomen, is distributed to the cremaster muscle. In the female it is a small branch, and it ends in the round ligament of the uterus and the labium pudendi. The *lumbo-inguinal branch* runs downwards along the lateral side of the external iliac artery, and, after crossing the deep circumflex iliac artery, it passes behind the inguinal ligament. Then it descends along the side of the femoral artery and after piercing the iliac part of the fascia lata it supplies the skin over a portion of the femoral triangle.

The *lateral cutaneous nerve of the thigh* (O.T. *external cutaneous nerve*) emerges from the lateral border of the psoas major about its middle, and descends obliquely across the iliacus muscle, behind the fascia iliaca, to the anterior superior spine of the ilium. At that point it leaves the abdomen by passing behind the inguinal ligament. It supplies the skin upon the lateral and anterior aspect of the thigh.

The *femoral nerve* (O.T. *anterior crural nerve*) is the largest branch of the plexus. It runs downwards in the interval between the psoas major and iliacus, and passes out of the abdomen behind the inguinal ligament. It gives a branch to the iliacus muscle.

The *obturator nerve* emerges from the medial border of the psoas major, where that muscle reaches the brim of the pelvis minor. Then it passes forwards and downwards upon the inner surface of the wall of the pelvis minor, a short way below the ilio-pectineal line of the hip bone. At the upper part of the obturator foramen it joins the artery of the same name, passes out from the pelvis minor and enters the thigh.

A small nerve, called the *accessory obturator*, is occasionally found. It may spring either from the obturator or from the third and fourth lumbar nerves. It proceeds downwards along the medial side of the psoas major, and it enters the thigh by passing over the pubic bone under cover of the pectineus. In the thigh it gives branches to the hip-joint, and unites with the obturator nerve. It sometimes supplies a twig to the pectineus muscle.

Truncus Lumbosacralis (O.T. Lumbo-sacral Cord).—The lumbo-sacral trunk is formed by the union of the anterior ramus of the fifth lumbar nerve with the descending branch of the fourth lumbar nerve. It passes downwards over the base of the sacrum, behind the common iliac artery, into the pelvis minor, where it joins the sacral plexus.

Last Thoracic Nerve.—The anterior ramus of the last thoracic nerve will be found running laterally in front of the quadratus lumborum, and under cover of the fascia spread over that muscle, along the lower border of the last rib. Near the vertebral column it sends a small offset downwards to the first lumbar nerve, and at the lateral border of the quadratus lumborum it pierces the aponeurosis of the transversus abdominis, and then passes forwards in the abdominal wall between that muscle and the internal oblique. Its course and distribution in the wall of the abdomen have already been described (p. 217).

Arteriæ Lumbales.—The lumbar arteries have been traced to the medial border of the psoas major. Thence they pass backwards, medial to the psoas major, to the intervals between the transverse processes of the vertebræ, where each gives off a dorsal branch.

Each *dorsal branch* runs backwards, between the adjacent transverse processes, and after giving a *spinal branch* which enters the vertebral canal through the intervertebral foramen, it ends in the muscles and integument of the back.

After giving off their *dorsal* branches, the trunks of the arteries, with the exception of the last, proceed laterally behind the psoas and the quadratus lumborum, and are then directed forwards between the internal oblique and transversus muscles, where they anastomose, *superiorly*, with the intercostal arteries, *inferiorly*, with the deep circumflex iliac and ilio-lumbar arteries, and *anteriorly*, with the branches of the superior and inferior epigastric arteries. The last lumbar artery, as a rule, passes in front of the quadratus lumborum.

Venæ Lumbales.—The lumbar veins accompany the corresponding arteries. The first, and sometimes the second, on the right side join the vena azygos, and the corresponding veins on the left side, end in the hemiazygos vein; the others pour their blood into the inferior vena cava. The lower veins of the left side pass behind the aorta. The lumbar veins of each side are linked together, in front of the transverse processes of the vertebræ, by anastomosing channels which form a continuous longitudinal vessel, called the *ascending lumbar vein.* The upper end of the ascending lumbar vein is connected with the corresponding azygos vein.

Subcostal Artery.—At this stage of the dissection the subcostal artery, the last parietal branch of the thoracic aorta, will be seen crossing the upper part of the quadratus lumborum, in company with the last thoracic nerve. It lies in series with the abdominal branches of the lumbar arteries and it accompanies the last thoracic nerve.

***Dissection.*—The lower limbs having, by this time, been removed from the trunk, the pelvis also may be detached. Place a ligature around the aorta and inferior vena cava at the level of the bifurcation of the former, and divide them immediately above that point. Then carry the knife through the intervertebral fibro-cartilage which intervenes between the third and fourth lumbar vertebræ, and, having cut the nerves and soft parts, complete the separation of the pelvis from the remainder of the trunk by means of a saw.**

PELVIS.

The pelvis, using the term in its widest sense, is the region bounded *posteriorly* by the sacrum and coccyx, and *laterally* and *anteriorly* by the hip bones. The bony wall is deficient, on each side posteriorly, between the sacrum and coccyx behind and the hip bone in front. The interval on each side is partially filled in by the ligamentum sacro-tuberosum (O.T. *great sacro-sciatic ligament*) and the ligamentum sacro-spinosum (O.T. *small sacro-sciatic ligament*), which divide it into the greater and lesser sciatic foramina. Anteriorly, on each side, the bony wall is broken by the obturator foramen, which is closed by the obturator membrane; and directly in front there is a gap bounded by the pubic arch and occupied by the urogenital diaphragm and its fasciæ (O.T. *triangular ligament*).

The area thus enclosed is separated into an upper and

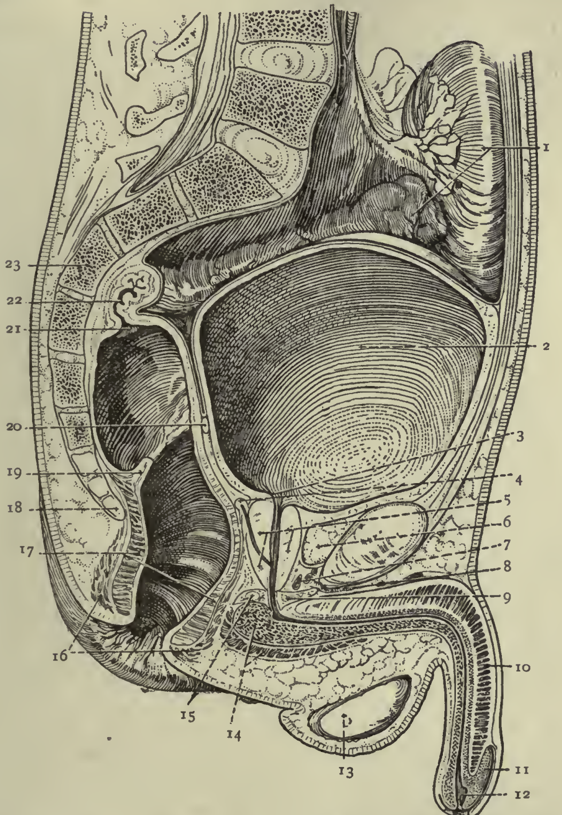


FIG. 189.—Sagittal section of the Pelvis of a young Male Adult with distended Bladder and Rectum.

1. Pelvic colon.
2. Urinary bladder.
3. Uvula of bladder.
4. Seminal vesicle.
5. Prostate.
6. Retro-pubic fat.
7. Pudendal plexus of veins.
8. Dorsal vein of penis.
9. Sphincter urethræ around membranous part of urethra.
10. Corpus cavernosum penis.
11. Glans penis.
12. Fossa navicularis of urethra.
13. Testis.
14. Bulb of urethra and bulbo-cavernosus muscle.
15 Bulbo-urethral gland.
16. External sphincter.
17. Internal sphincter.
18. 4th piece of coccyx.
19. 2nd transverse rectal fold.
20. Ductus deferens.
21. 1st transverse rectal fold.
22. Commencement of rectum.
23. 3rd sacral vertebra.

a lower part by an imaginary plane, the plane of the pelvis brim. The margin of this plane is the linea terminalis which is separable into sacral, iliac, and pubic portions. The sacral part of the linea terminalis is formed by the upper border of the anterior surface of the first sacral vertebra and the anterior margins of the ulæ of the sacrum. The ilio-pectineal lines of the iliac and pubic bones and the crest of the pubic bones constitute the iliac and pubic portions. The part above the plane is the pelvis major (O.T. *false pelvis*), which has already been studied as part of the abdomen. The part below the plane is the pelvis minor (O.T. *true pelvis*). The inner aspect of the wall of the pelvis minor is partially covered by the following muscles. *Posteriorly*, on the front of the sacrum, are the two *piriformes muscles*. *Laterally*, on the inner surface of each hip bone, is the *obturator internus muscle*. *Anteriorly* is the uro-genital diaphragm, formed by the deep transverse perineal muscles and the *sphincter urethræ membranaceæ*. The inner surfaces of the muscles mentioned and the intervening skeletal structures are covered by a continuous layer of fascia, the *parietal pelvic fascia*. The wall of the pelvis minor may, therefore, be regarded as consisting of three strata, viz.—1. A bony stratum. 2. A muscular stratum. 3. A membranous stratum.

The pelvis minor is separated into an upper part and a lower part by the *pelvic diaphragm* and the fascia covering it. The pelvic diaphragm is formed by the two *levatores ani* and the two *coccygei muscles*. In the following account the upper part will be spoken of as the *pelvis minor*. The lower part has already been called the *perineum*.

The pelvis minor, as thus defined, is the smaller, basin-shaped, lower part of the abdominal cavity above the pelvic diaphragm. It communicates with the upper portion through a somewhat constricted aperture, the superior aperture of the pelvis minor.

The contents of the pelvic cavity differ in the two sexes; in both, however, the bladder occupies the anterior part of the space, and the rectum and pelvic colon the posterior part. The difference is to be found in the generative organs and their blood-vessels. It is necessary, therefore, to describe the male and the female pelvis minor separately.

Male Pelvis Minor.

The male pelvis minor contains the following structures :—

Viscera.	The rectum and the pelvic colon.[1] The urinary bladder, with the lower portions of the ureters, the prostate, and the prostatic part of the urethra.[1] The ductus deferentes and the vesiculæ seminales.[1]
Blood-Vessels.	The hypogastric vessels and their branches and tributaries. The superior hæmorrhoidal vessels. Venous plexuses associated with the viscera.
Nerves.	The pelvic plexuses of the sympathetic system and their offshoots. The obturator nerves.
Other Structures.	The extraperitoneal fat. The pelvic part of the peritoneum.

The following structures lie between the pelvic fascia and the bony and muscular strata of the pelvic wall :—

Blood-Vessels.	The middle sacral vessels. The parietal branches of the hypogastric vessels, after they have pierced the fascia.
Nerves.	The sacro-pudendal and coccygeal plexuses of nerves. The pelvic parts of the sympathetic trunks.

General Position of the Viscera.—The *pelvic colon* and the *rectum* occupy the posterior part of the cavity, the colon extending in flexuous curves from the left margin of the superior aperture of the pelvis minor to the middle of the third piece of the sacrum, where it becomes the rectum. The rectum follows the concavity of the sacrum and coccyx, and runs forwards to the base of the urinary bladder (Figs. 189, 190). The *urinary bladder* lies in the anterior part of the cavity, behind the pubic bones, and in front of the rectum. The *seminal vesicles* lie in a plane between the bladder and the rectum, and the ductus deferentes having crossed the brim, behind the origins of the inferior epigastric arteries, run downwards and backwards, and then turn medially, across the ureters, to gain the base of the bladder, at the medial sides of the seminal vesicles. The pelvic portions of the ureters can be seen descending, outside the peritoneum, along the fronts of the hypogastric arteries, and turning medially, below the

[1] Strictly speaking, the urinary bladder, the prostate, the seminal vesicles, and the lower parts of the rectum, ductus deferentes and ureters are not in the pelvis, for they are embedded in the pelvic fascia and, therefore, lie in the pelvic wall.

ductus deferentes, towards the base of the bladder. The prostate lies below the bladder and encloses the prostatic part of the urethra (Fig. 190).

The Pelvic Peritoneum.—The peritoneum passes into the pelvis minor through the superior aperture, and gives partial or complete coverings to various viscera. It covers the upper surface of the bladder, and passes from the lateral borders of that surface to the side walls of the pelvic cavity, as the *lateral*

FIG. 190.—Median section through the Male Pelvis. The bladder, which is empty, does not present the usual form.

false ligaments of the bladder. Turning over the posterior border of the upper surface of the bladder, it descends, for a slight distance, on the fundus or base of the viscus, and then, if the bladder is empty, it projects backwards as a semilunar ledge or fold, called the *sacro-genital fold* (Fig. 191.) In the middle portion of that fold the seminal vesicles are enclosed and parts of the ductus deferentes. The lateral borders of the fold curve backwards to the sacrum, passing at some little distance from the sides of the rectum. From the lower surface of the sacro-genital fold the peritoneum passes to the front of the rectum, on which it is reflected upwards to the pelvic colon. Below the line of reflection from the sacro-genital fold there is a part of the rectum entirely devoid of peritoneal covering. The part immediately above that is covered only in front, but at a higher level the front and the sides also are covered; and when the pelvic colon is reached the peritoneum entirely surrounds that part of the gut and attaches it to the posterior wall of the pelvis by a fold or mesentery, called the *pelvic meso-colon*. The hollow or pouch between the sacro-genital fold in front and the rectum behind is the *recto-vesical* or *recto-genital pouch*.

The Peritoneal Fossæ.—As the peritoneum follows the contours of the more projecting viscera, three hollows or secondary pouches are formed on each side: an *anterior* or *paravesical*, a *middle* or *genital*, and a *posterior* or *pararectal*. The paravesical fossa is bounded medially by the bladder, laterally by the pelvic wall, and posteriorly by a ridge of peritoneum, caused by the ureter, which runs backwards and laterally from the postero-lateral angle of the upper surface of the bladder towards the hypogastric artery. Beneath the floor of the paravesical fossa the ductus deferens runs medially towards the genital fossa. The genital fossa lies between the ureteral ridge and the margin of the sacro-genital fold; and the pararectal fossa is between the sacro-genital fold and the side of the rectum. The two pararectal fossæ are continuous with each other across the front of the rectum and form together the recto-vesical pouch. When the rectum is distended the peritoneum of the pararectal fossæ is lifted up to cover the expanding wall of the viscus, the pararectal fossæ are obliterated, and the posterior ends of the sacro-genital folds terminate on, or in close relation with, the wall of the rectum. When the bladder is distended the middle part of the sacro-genital fold is also opened out to help to cover the upper part of the fundus of the bladder, but the lateral parts remain. If, however, the bladder and rectum are simultaneously distended the lateral parts of the sacro-genital fold pass from the back of the bladder either to the rectum or to the posterior wall of the pelvis close to the rectum, and under those conditions the folds in question were formerly described as the *recto-vesical folds* or *posterior false ligaments* of the bladder.

The False Ligaments of the Urinary Bladder.—The false

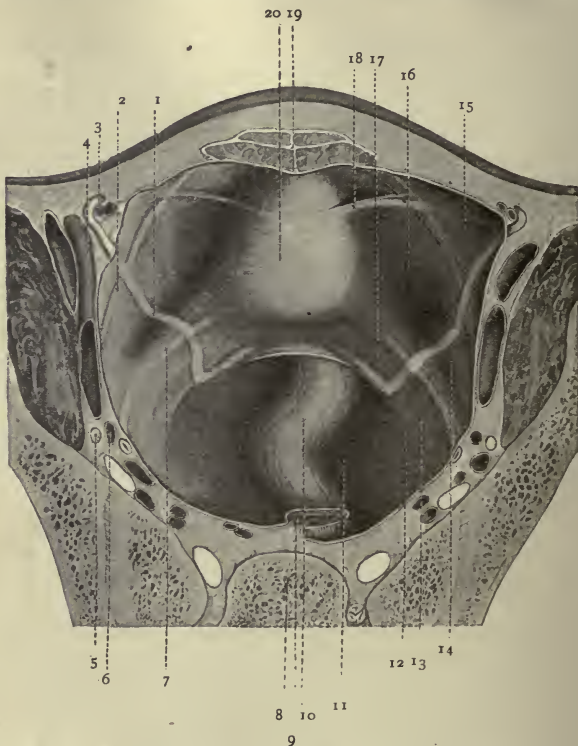


FIG. 191.—The Peritoneum of the Cavity of the Pelvis Minor.

The upper part of the posterior wall of the pelvis minor has been removed to show more clearly the disposition of the peritoneum within its cavity. (Dixon and Birmingham.)

1. Ductus deferens.
2. Umbilical artery.
3. Inferior epigastric artery.
4. External iliac vessels.
5. Obturator nerve.
6. Umbilical artery.
7. Ureter.
8. Third sacral vertebra.
9. Lower part of pelvic meso-colon.
10. Rectum.
11. Pararectal fossa.
12. Sacro-genital fold.
13. Lateral portion of middle fossa.
14. Genital fossa.
15. Lateral inguinal fovea.
16. Paravesical fossa.
17. Median portion of middle fossa.
18. Plica vesicalis transversa.
19. Urachus.
20. Bladder.

ligaments of the bladder are parts of the pelvic peritoneum. When the bladder is empty, a fold called the *plica umbilicalis* *media* (O.T. *superior false ligament*) extends from the anterior end of its upper surface, *i.e.*, the *apex* of the bladder, to the posterior surface of the anterior abdominal wall. It is caused by the projection of the *ligamentum umbilicale medium*, which consists of the urachus, a fibrous remnant of part of the cloaca, and it separates the paravesical and supravesical fossæ from the corresponding fossæ of the opposite side. The peritoneum extending from each lateral border of the upper surface of the bladder to the side wall of the pelvis constitutes a *lateral false ligament*, and forms the floor of the corresponding paravesical fossa. Not uncommonly each lateral false ligament and the peritoneum on the upper surface of the bladder are divided into anterior and posterior portions by a transverse fold, the *plica vesicalis transversa*, which crosses from one side of the superior aperture of the pelvis minor to the other. It is questionablc if the term *posterior false ligament* should be retained; it is still applied, however, to the remnants of the sacro-genital folds which extend from the back of the distended bladder to the sides of the distended rectum, or to the front of the sacrum.

Dissection from above.—All the peritoneum above the level of the pelvic brim should now be removed, care being taken not to injure or displace the ureter or the ductus deferens. The dissector should then stitch the ureter to the artery it crosses at the brim, common or external iliac as the case may be. He must also stitch the ductus deferens to the external iliac artery, close to the origin of the inferior epigastric branch. That being done, he must carefully detach the peritoneum from the extraperitoneal fat, separating any adhesions with the knife. The separation should be commenced at the brim, and be carried medially until the root of the pelvic meso-colon, the side of the rectum, and the lateral border of the upper surface of the bladder are reached.

When that stage has been attained on both sides, the dissector should displace the bladder backwards, and pass his finger down between the viscus and the symphysis, through the soft extraperitoneal fat, till it meets a resisting membrane. The membrane is the visceral layer of the pelvic fascia or upper layer of the fascia of the pelvic diaphragm. By his sense of touch the dissector will recognise not only that it is attached to the lower part of the posterior surface of the symphysis, but also that two thickened bands of its substance extend backwards, one on each side of the median plane, from the back of the symphysis to the anterior border of the bladder. The bands are the *anterior true ligaments* of the bladder or the medial *pubo-prostatic ligaments*, the latter name indicating that, in the male, they are placed above the prostate. Having satisfied himself regarding the pubo-prostatic ligaments, the dissector should carry his finger backwards, between the bladder and the wall of the pelvis, displacing the soft fat, until he touches the ureter. The region which he will thus investigate is the lower and anterior part of a large area, known as the *cave of Retzius*, in which the extraperitoneal fat has very slight attachment either to the peritoneum or to the pelvic fascia, and in which, therefore, it is very easily displaced. The area extends from the hypogastric artery of one side round the front of the bladder to the hypogastric artery of the opposite side, downwards to the visceral layer of the pelvic fascia, and upwards, between the umbilical (O.T. obliterated hypogastric) arteries, to the umbilicus. The facility with which he displaces the fatty tissue should demonstrate to the dissector how easy, in that area, will be the spread of urine effused from a ruptured bladder, or of blood running from a divided artery, or of effusions due to inflammatory conditions.

The dissector must now remove the extraperitoneal fat first from the ductus deferens, then from the region of the ureter, and afterwards from the hypogastric vessels and their branches and tributaries. Whilst that is being done, the obturator nerve will be brought into view to the lateral side of the ureter, and below the level of the umbilical artery. Whilst removing the fat and displaying the structures embedded in its substance, the dissector must be careful not to injure either the parietal or the visceral pelvic fascia. He will find that some of the branches of the hypogastric artery pierce the parietal fascia as they leave the pelvis, and that the visceral branches, the rectum, the ureter, and the ductus deferens, pass into the substance of the visceral layer.

When the dissection is completed the student should note the relative positions of the structures he has exposed. The ductus deferens will be seen passing downwards and backwards, on the side wall of the pelvis, till it meets the ureter, which is passing downwards, from the junction of the lateral and posterior walls of the cavity and along the front of the hypogastric artery. Before they meet, both the ductus deferens and the ureter turn medially and, medial to the point of crossing, they both enter the visceral layer of the pelvic fascia. Behind the ureter is the hypogastric artery, dividing into its anterior and posterior divisions. Running forwards on the lateral side of the ureter and the ductus deferens are the umbilical, the obturator, the middle and inferior vesical, and, not uncommonly, the middle hæmorrhoidal branches of the anterior division of the hypogastric artery. Springing from the umbilical artery are one or more superior vesical arteries, whilst below the umbilical artery and above the obturator artery is the obturator nerve, which pierces the parietal fascia at the back of the pelvis and runs forwards, above the corresponding artery and vein, to the obturator canal. Behind the ureter the lateral sacral branches and the gluteal continuation of the posterior division of the hypogastric artery will be seen piercing the pelvic fascia, and when the posterior division of the artery is displaced medially its ilio-lumbar branch will be found. The

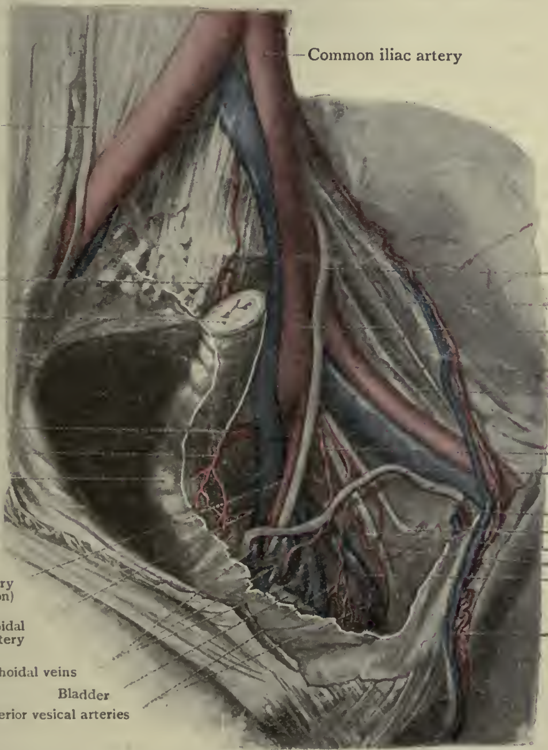


FIG. 192.—The Structures exposed in the left half of the Pelvis Minor by the removal of the peritoneum and extraperitoneal fat.

hypogastric vein lies along the posterior border of the artery, and those of its tributaries which correspond to the anterior branches of the artery pass, usually, to the medial side of the anterior division of the artery on their way to the main vein. There is no vein with the umbilical artery or its superior vesical branch. As a rule only one vein accompanies the obturator artery, but the inferior vesical and middle hæmorrhoidal veins are usually numerous, and, as they pass to their termination, they ensheathe the lower part of the ureter. The lateral sacral and gluteal veins end in the hypogastric vein, but the ilio-lumbar vein is, usually, a tributary of the common iliac vein.

Endo-Pelvic Fascia.—When the dissector has studied the general position of the structures exposed by the removal of the peritoneum and the extraperitoneal fat of the pelvis, he should turn his attention to the endo-pelvic fascia. It consists of two main parts: a parietal part, which forms part of the pelvic wall, and a diaphragmatic part, which covers the upper and lower surfaces of the pelvic diaphragm. The upper fascia of the diaphragm is known as the *visceral layer* of the pelvic fascia, because it enters into intimate relationship with the pelvic viscera. The visceral part of the pelvic fascia stretches across the cavity, from side to side and from front to back, and helps to separate the perineum from the remainder of the pelvis.

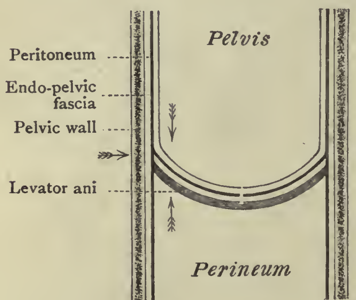


FIG. 193.—Diagram of the Pelvic Wall and Pelvic Floor.

If the upper part of the parietal layer is examined it will be found that it is continuous at the pelvic brim with the fascia on the psoas major muscle, from which it descends to the level of a line drawn from the lower part of the back of the body of the pubis to the spine of the ischium. At that level the visceral layer springs from the parietal layer, its origin serving to separate the latter into lower and upper parts. If the upper part of the parietal portion is traced backwards it will be found to extend round the lateral side of the hypogastric vessels and across the front of the sacrum, behind the pelvic meso-colon and the rectum, to the opposite side. If it is traced forwards, a short distance below the brim, it will be found to blend with the periosteum on the back of the superior ramus of the pubis, along an oblique line which descends from the junction of the middle third with the lower third of the external iliac artery to the upper margin of the obturator foramen. Below the superior ramus of the pubis it forms a distinct thickened border which bridges across the upper part of the obturator foramen, and forms the lower boundary of the commencement of the obturator canal, by which the obturator artery and nerve leave the pelvis. To the medial side of the obturator foramen the parietal fascia blends with the

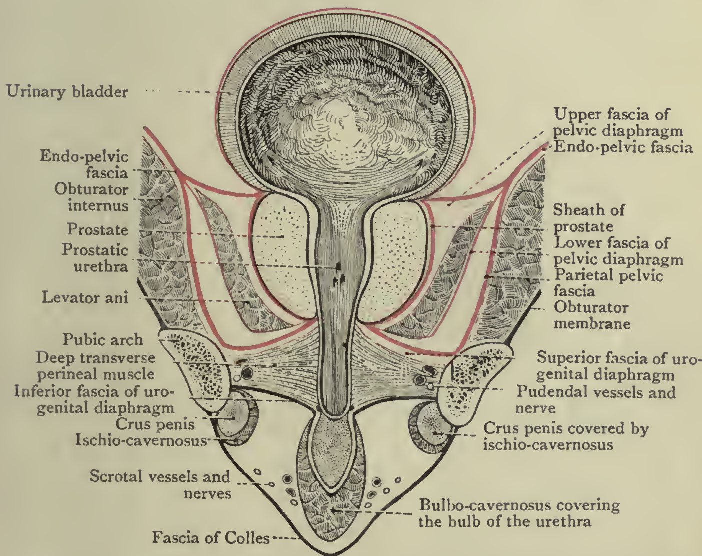


FIG. 194.—Vertical transverse section through the Bladder, Prostate, and Pubic Arch to show the arrangement of the Endo-pelvic Fascia: schematic. The endo-pelvic fascia is depicted in red.

periosteum on the back of the body of the pubis, along a line which descends towards the apex of the pubic arch and passes below the line of attachment of the visceral layer. The parietal layer is deficient, therefore, in the region of the upper part of the anterior wall of the pelvis, and as its anterior margin blends with the periosteum on the pubis any effusion lying external to the fascia will be prevented from extending forwards to the anterior part of the pelvis.

The lower part of the parietal layer should next be examined. In the dissection of the perineum the student saw that the lower part of the parietal pelvic fascia lined the lateral wall of the ischio-rectal fossa, and that it blended, immediately below the origin of the levator ani, with the lower layer of the fascia of the pelvic diaphragm, which covers the lower surfaces of the levator ani and the coccygeus (anal fascia). He saw also that, in the anterior part of the perineum, the parietal fascia extended medially, as the *superior fascia of the urogenital diaphragm*, from the margin of the pubic arch to the side of the urethra, where it not only blended with the fascia coming from the opposite side, but

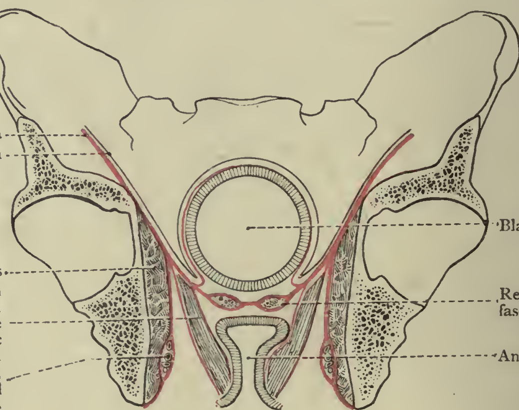


FIG. 195.—Diagram of the Endo-pelvic Fascia. The pelvis is divided in a frontal plane and the pelvic fascia is represented in red.

also became continuous, round the anterior border of the levator ani, with the fascia on the upper surface of that muscle, that is, with the visceral layer of the pelvic fascia.

To display the details of the visceral layer of the fascia the final stages of the dissection of the perineum must now be completed.

Dissection.—The dissector must carefully define the anterior borders of the levatores ani muscles, and then he must cut boldly through the centre of the perineum between the bulb and the anal orifice until he reaches the fascial interval between the posterior surface of the prostate and the front of the lower part of the rectum. When the interval is reached the knife may be discarded and the forefinger introduced into the space and carried from side to side. In that way it is possible to demonstrate that the visceral layer of the pelvic fascia, as it descends on the levator ani, divides into a lower layer, which passes behind the rectum, and a layer which passes between the rectum and the prostate—the recto-vesical layer (Fig. 195).

The right levator ani must now be divided, from before backwards, about midway between its origin from the parietal fascia and its insertion into the wall of the anal passage, care being taken to avoid injury to the fascia on its upper surface. The lower part of the muscle should be followed to its insertion into the wall of the anal canal, and the mode of insertion between the internal and the external sphincters noted. The upper part should be turned laterally and the fingers of the left hand passed along its upper surface till its origin from the fascia is reached. When that is done the dissector will find that the only structure which separates his fingers from the cavity of the pelvis is the upper layer of the fascia of the pelvic diaphragm (*visceral layer of the pelvic fascia*), which extends from the parietal fascia, at the level of the origin of the levator ani, and passes medially to the walls of the viscera, which it ensheathes. If the dissector will now place the fingers of one hand on the upper surface of the visceral fascia and those of the other hand on the lower surface, and then carry both hands medially, he will find that the one hand passes on to the upper surface of the bladder and the other behind the rectum. He will thus demonstrate that as the visceral fascia crosses the pelvis from side to side it separates into an upper or vesical layer and a lower or rectal layer. The third or recto-vesical layer, which covers the posterior surface of the prostate, and separates the gland from the rectum, has already been demonstrated. The recto-vesical layer must now be incised, in the median plane, on the posterior surface of the prostate and each half must be turned laterally. As the borders of the prostate are approached a plexus of veins will be exposed on each side, and immediately beyond the plexus the recto-vesical layer of the fascia will be found to blend with the vesical layer, which passes over the upper surface of the prostate. The ductus deferentes and the seminal vesicles will be exposed when the reflection of the recto-vesical layer is carried backwards beyond the prostate (Fig. 196).

The True Ligaments of the Bladder.—There are five so-called true ligaments of the bladder: two *lateral*, the lateral pubo-vesical ligaments; two *anterior*, the medial pubo-vesical ligaments (pubo-prostatic in the male); and one *superior*. The lateral are the lateral parts of the vesical layer of pelvic fascia. The anterior are two thickenings of the same layer, one on each side of the median plane, in front of the bladder; they contain smooth muscle fibres which pass from the bladder to the back of the pubic bones at the margins of the symphysis. The superior, the lig. umbilicale medium, is the urachus.

During the various stages of this dissection the student should repeatedly convince himself, by introducing the index finger of his right hand into the rectum and that of his left hand into the pelvis, that he can quite easily define the outlines of the prostate and the seminal vesicles by a process of palpation; and when he has completed the dissection he should note that he has demonstrated that the visceral layer of the pelvic fascia, which is single laterally, is cleft medially

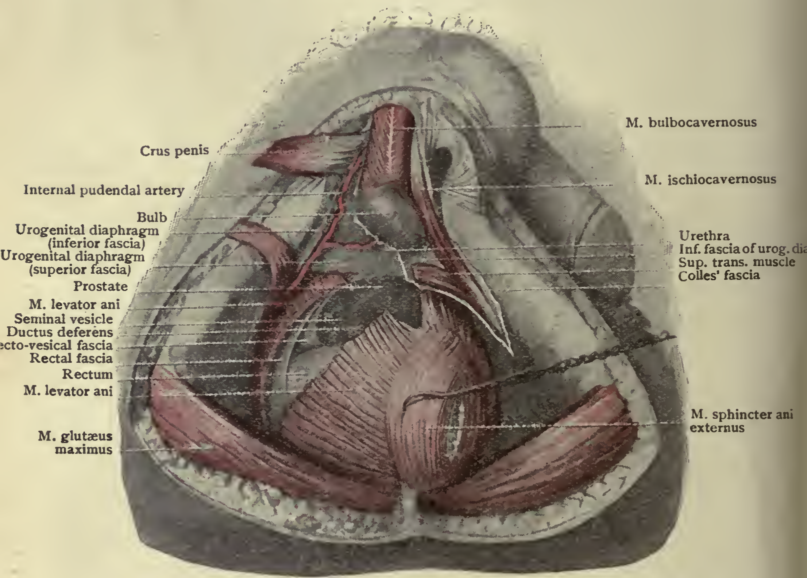


FIG. 196.—Dissection to expose the Prostate from the Perineum.

into three lamellæ by the interposition of the rectum between a middle and a lower layer, and the interposition of the bladder and the prostate between the middle and an upper layer. There are two compartments, therefore, in the substance of the fascia: a lower or posterior, which contains the rectum; and an upper or anterior, in which lie the bladder, the prostate, the seminal vesicles, and the lower parts of the ductus deferentes.

Dissection.—The suspensory ligament of the penis, which has already been defined (see p. 245), must now be detached from the front of the symphysis. The left crus of the penis has already been separated, and the right crus should now be cut away from the margin of the pubic arch and the inferior fascia of the urogenital diaphragm, care being taken to avoid injuring the latter. As the penis is turned down, the median and single deep dorsal vein will be seen to pass backwards, between the arcuate ligament and the upper border of the transverse ligament of the pelvis (which is the thickened upper border of the fasciæ of the urogenital diaphragm), into the pelvis, where it will be followed at a later stage. The dorsal artery and the dorsal nerve of the penis pierce the inferior fascia of the urogenital diaphragm near the anterior part of the margin of the pubic arch, and the deep

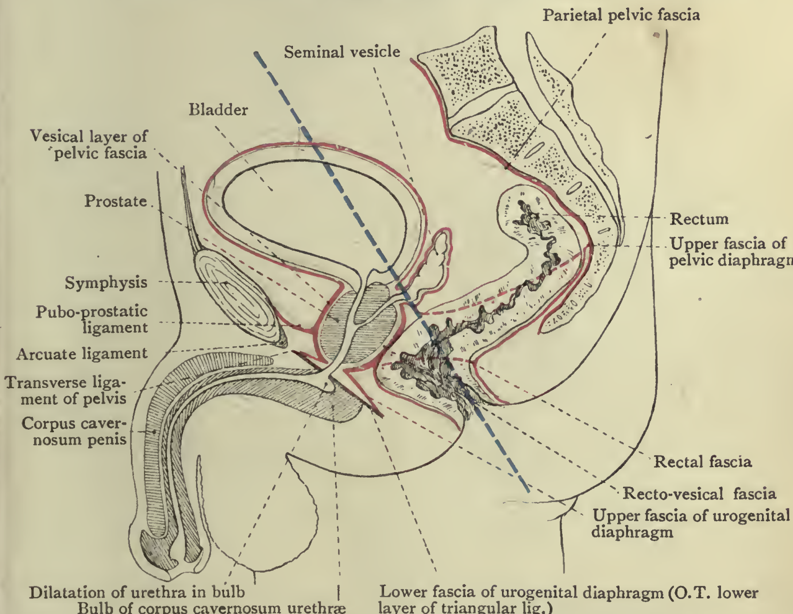


FIG. 197.—Diagram of the Pelvic Fascia as seen in a sagittal section of the Pelvis. Pelvic fascia represented in red.

artery of the penis frequently passes through the same fascia immediately to the lateral side of the nerve (Fig. 198). The proximal parts of the structures mentioned have already been seen in the dissection of the perineum. The bulb of the urethra should now be carefully detached from the anterior part of the inferior fascia of the urogenital diaphragm and turned downwards until the urethra is brought into view. The urethra pierces the anterior part of the fascia in the median plane and passes at once into the bulb.

The muscles and fascia must now be detached from the anterior surfaces and upper borders of the bodies of the pubic bones, and from the upper parts of the pubic rami. Then the bones must be cut through, with the saw, on each side, along a line running from below the attachment of the arcuate ligament up to the lateral side of the pubic tubercle (see Fig. 198). By the saw-cuts a considerable part of the anterior wall of the pelvis is isolated, and it can be removed when the vesical layer of the

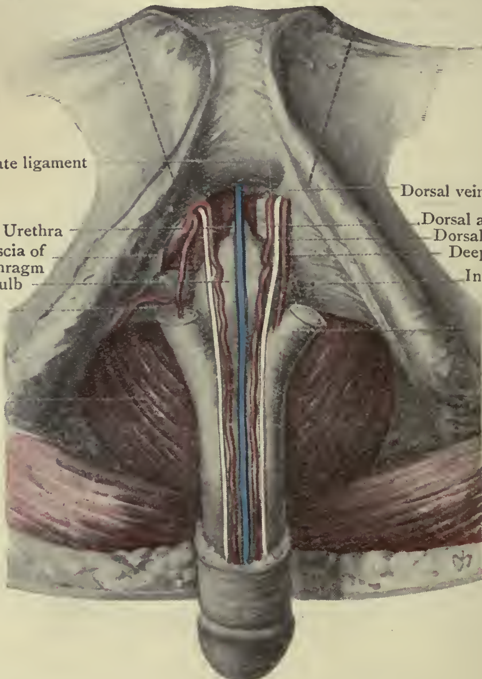


FIG. 198.—Dissection to show the Dorsal Vessels and Nerves of the Penis and their relations to the fasciæ of the Urogenital Diaphragm. The upper part of the deep transverse perineal muscle has been left between the two fasciæ. The lower part has been removed to expose the superior fascia. The lines of the saw-cuts made in the dissection are indicated on the bones by the dotted lines.

endo-pelvic fascia has been detached from its posterior surface. Having been removed, it must be kept for the examination of the inter-pubic joint. Whilst the bone is being removed care must be taken to avoid injuring the dorsal vein of the penis.

After the bone is removed the dissector will see the anterior border of the vesical layer of the pelvic fascia, which has been detached from the back of the pubis. In the fascia he will readily recognise the thickened bands of the pubo-prostatic ligaments. The vesical layer must now be divided in the median plane and turned laterally to each side. Whilst that is being done it will be noticed that, above the prostate, the vesical layer is gradually lost on the anterior border and infero-lateral surfaces of the bladder (Fig. 199). When the fascia has been turned laterally to its junction with the recto-vesical layer, already displayed from below, the dorsal vein of the penis must be followed backwards. It divides, immediately after entering the pelvis, beneath the vesical layer of fascia, into right and left branches which join the corresponding parts of the pudendal (O.T. *prostatic*) venous plexus.

The dissector should notice that, by the removal of the bone in the region of the symphysis, he has exposed not only the structures already noted, but also the whole of the anterior border of the bladder and parts of its infero-lateral surfaces. If he now replaces the pelvic peritoneum, he will find that it has no relation to the border and surfaces mentioned; they lie entirely below the level of the peritoneum. They form the posterior boundary of the lower part of the cave of Retzius, and lie in relation with the anterior and antero-lateral parts of the pelvic wall, from which they are separated by the extraperitoneal fatty tissue which was removed at an earlier stage of the dissection. The dissector has now seen three surfaces of the bladder—the superior surface, covered with peritoneum, and the two infero-lateral surfaces. The bladder possesses also a fourth surface, the fundus or base, which lies in relation with the deferent ducts, the seminal vesicles, and to a less extent with the lower part of the anterior wall of the rectum. That surface and the interior of the bladder should now be investigated.

Dissection.—Enter the knife through the anterior border of the bladder, a little below its upper extremity, and carry it backwards first on one side and then on the other, just below the upper border of each infero-lateral surface. When the incisions have been made, push the upper surface of the bladder backwards and press the infero-lateral surfaces downwards and forwards. An excellent view of the interior will thus be obtained, and, when its surface has been sponged, the mucous lining and the orifices may be examined, and the relations of the base may be investigated. If it is necessary, the anterior border may be divided vertically from the apex of the bladder to the upper border of the prostate.

Interior of Bladder.—The mucous membrane is rugose, when the bladder is empty, over the whole of the inner surface, except a small triangular area on the basal wall (Fig. 200). The rugosity is due to the loose manner in which the membrane is bound to the muscular coat by the layer of submucous tissue. When the bladder is distended the folds are effaced, and the mucous lining becomes smooth throughout.

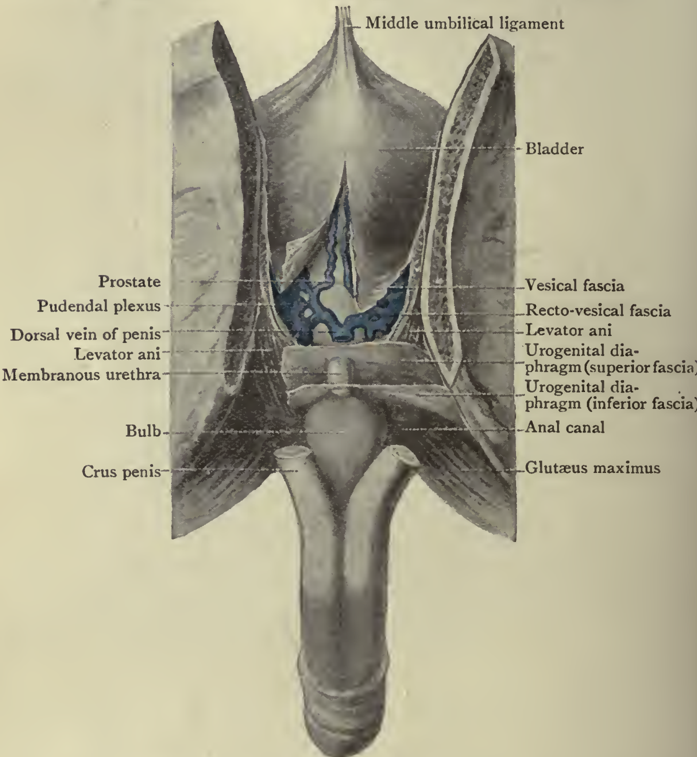


FIG. 199.—Dissection of the Bladder, the Endo-Pelvic Fascia, and the Prostate from the front. The sphincter of the membranous part of the urethra has been removed from between the two layers of the fascia of the urogenital diaphragm.

Orifices and Trigone of the Bladder.—There are three orifices in the bladder wall—two orifices of inlet, the orifices of the ureters; and one orifice of outlet, the orifice of the urethra. They are situated at the three angles of the triangular smooth area of the mucous membrane which is known as the *Trigonum Vesicæ* (*Trigone of the Bladder*). In that area the mucous membrane is always smooth, whether the bladder is distended or empty, on account of the close connection which exists between the mucous and muscular coats. At the inferior angle of the area is the internal urethral orifice, semilunar or V-shaped in outline, with a

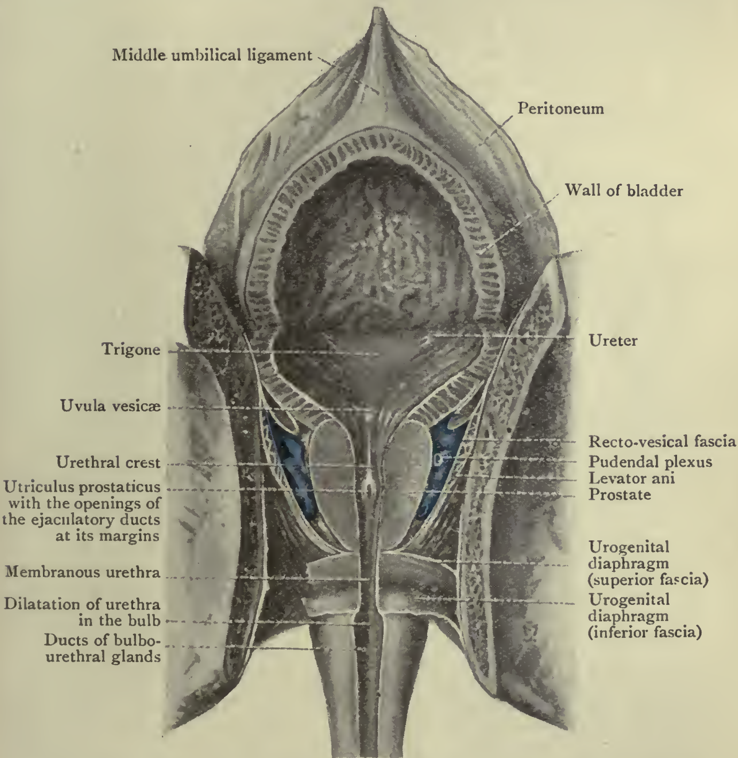


FIG. 200.—Dissection of Bladder and Urethra from the front. The sphincter of the membranous part of the urethra has been removed from between the two fasciæ of the urogenital diaphragm.

slightly elevated posterior lip, which is known as the *uvula* of the bladder (Figs. 189 and 200). The elevation indicates the position of the middle lobe of the prostate gland below. When the bladder is empty and contracted a number of radial ridges of mucous membrane diverge from the margins of the orifice.

The ureteral orifices lie at the superior angles of the trigone. They are small semilunar slits, and are frequently connected together by a transverse bar of mucous membrane (*torus vesicalis*) which covers a bar of muscle. Not uncommonly a ridge of mucous membrane covering a muscular band will be found connecting each ureter with the urethra. Probes should be passed along the ureters to demonstrate the obliquity with which the ducts pass through the bladder wall. It will be found that each ureter runs through the substance of the bladder wall for about 20 mm. (three-quarters of an inch). This arrangement serves the purpose of a valve which allows urine to pass easily into the bladder but tends to prevent its backward flow. When the bladder is distended the openings of the ureters are about 35 mm. (an inch and a half) apart, and about the same distance from the orifice of the urethra, but when the viscus is empty and contracted the distance between the orifices is reduced to about 25 mm. (one inch) in each case.

The dissector should now investigate the relations of the fundus of the bladder by palpation. Keeping one index finger in the bladder and passing the other into the rectum, he will find that he can distinguish the prostate below and around the internal urethral orifice. Above the level of the prostate he can feel the thick walls of the deferent ducts, one on each side of the median plane, and more laterally he will recognise the convoluted coils of the seminal vesicles. If he passes his finger upwards, along the median plane, he will find that the deferent ducts diverge, and that between them the rectum and bladder lie in contact. The area in which that contact occurs corresponds with the posterior part of the trigone, and varies considerably in size. When the bladder is empty the area is small or absent; but it increases considerably when the bladder is distended.

Dissection.—When the dissector has satisfied himself regarding the relations of the base of the bladder and the possibility of easily distinguishing them with the finger through the rectal wall, he should introduce a blunt-pointed knife, or a pair of scissors, through the internal urethral orifice into the urethra, and lay the canal open by dividing its dorsal wall from the bladder to the end of the penis.

Urethra Virilis.—The male urethra is the canal through which the urine, the semen, and the secretions of the seminal vesicles, the prostate and bulbo-urethral glands

(Cowper's), are emitted from the body. It commences at the internal urethral orifice of the urinary bladder and ends on the glans penis. Its average length is 200 mm. (eight inches). It is customary to divide the canal into three parts, from the different characters of the structures which it

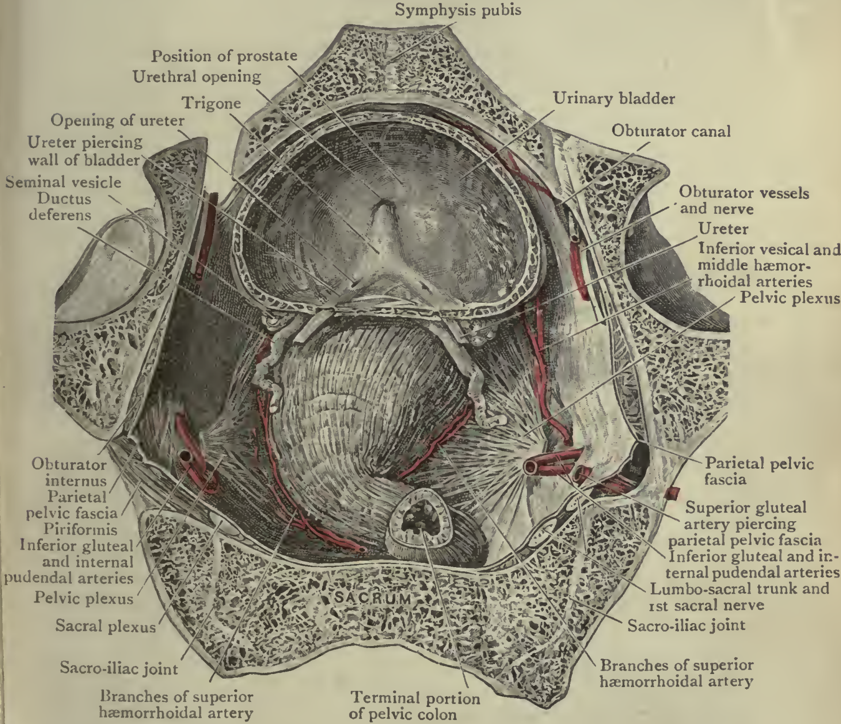


FIG. 201.—Oblique section from above downwards and forwards through the Pelvis. The peritoneum has been removed so as to expose the viscera and the parietal pelvic fascia clothing the pelvic wall.

traverses. The first part, *pars prostatica urethræ*, is contained within the substance of the prostate gland; the second part, *pars membranacea urethræ*, extends from the prostate to the bulb of the corpus cavernosum urethræ, and is surrounded, between the fasciæ of the urogenital diaphragm, by the fibres of the sphincter muscle of the membranous urethra; the third part, *pars cavernosa urethræ*, traverses the entire length of the corpus cavernosum urethræ.

Pars Prostatica Urethræ.—The prostatic part of the urethra is about 30 mm. (one inch and a quarter) in length. It is fusiform, being wider in the middle than at either its commencement or its termination. It traverses the prostate in front of its so-called middle lobe, and takes a very nearly vertical course through the substance of the prostate. It is the widest, and at the same time the most dilatable, part of the canal.

In connection with the posterior wall or floor of the prostatic portion of the urethra there are certain important features to be noted. The mucous membrane along the median plane is raised into a prominent ridge called the *crista urethræ*. The urethral crest commences a short distance below the internal orifice of the urethra, and extends downwards for about three-quarters of an inch. At first it increases gradually in height, until it forms a prominent eminence, the *colliculus seminalis* or seminal hillock; then its height suddenly diminishes, and, finally, the ridge fades away into the membranous part of the canal (Fig. 200). On each side of the urethral crest the floor of the urethra is a longitudinal depression, termed the *prostatic sinus*, into which the numerous prostatic ducts open. The dissector may render the prostatic ducts evident by squeezing the prostate, when fluid will be found to exude into the sinuses through the ducts. A close inspection of the floor of the urethra, above the crista, will reveal the apertures of the ducts of the so-called middle lobe of the prostate.

Immediately below the seminal hillock the mucous membrane dips backwards and upwards, forming a small *cul-de-sac*, the *utriculus prostaticus*, behind the middle lobe of the prostate (Fig. 203). The orifice of the prostatic utricle is narrow, but the recess widens out towards its blind upper end, and its length, which may be gauged with a probe, varies from 6 to 12 mm. (a quarter to half an inch). It is of interest both practically and developmentally,—practically, because it is sometimes large enough to entangle the point of a small catheter or bougie; and developmentally, because it represents, in the male, the vagina and uterus of the female.

On the margins of the orifice of the prostatic utricle the dissector will find the slit-like orifices of the *ejaculatory* *ducts* (Fig. 200). The ducts themselves run downwards,

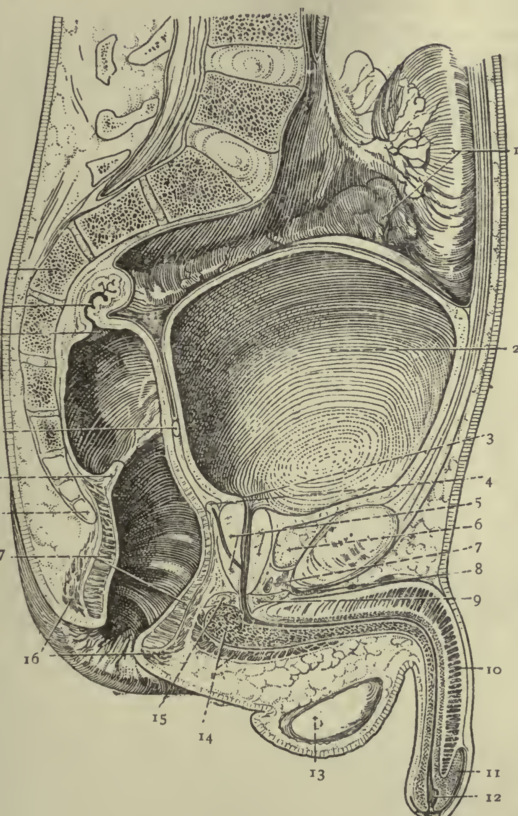


FIG. 202.—Sagittal section of the Pelvis of a young Male Adult with distended Bladder and Rectum.

1. Pelvic colon.
2. Urinary bladder.
3. Uvula of bladder.
4. Seminal vesicle.
5. Prostate.
6. Retro-pubic fat.
7. Pudendal plexus of veins.
8. Dorsal vein of penis.
9. Sphincter urethræ around membranous part of urethra.
10. Corpus cavernosum penis.
11. Glans penis.
12. Fossa navicularis of urethra.
13. Testis.
14. Bulb of urethræ and bulbo-cavernosus muscle.
15. Bulbo-urethral gland.
16. External sphincter.
17. Internal sphincter.
18. 4th piece of coccyx.
19. 2nd transverse rectal fold.
20. Ductus deferens.
21. 1st transverse rectal fold.
22. Commencement of rectum.
23. 3rd sacral vertebra.

along the lateral walls of the utricle, between the middle and lateral lobes of the prostate. Bristles should be passed through the apertures into the ducts.

Owing to the projection of the urethral crest from the middle of the floor of the canal a transverse section of the prostatic portion of the urethra presents a crescentic figure—the convexity of the crescent being directed forwards and the concavity backwards.

The prostate is very liable to become enlarged as old age approaches. When that happens the most important result is the effect exerted on the urethra. If the enlargement is uniform the canal is merely lengthened, but if excessive growth is localised the enlarged part may compress the urethra and interfere with micturition. When the middle lobe enlarges it projects upwards and forwards, over the internal orifice of the urethra, and forms a kind of ball valve, which may prevent the exit of urine through the internal urethral orifice. It is only in pathological conditions that the so-called middle lobe becomes a very distinct and more or less independent part of the organ. During health it is marked off from the rest of the prostate merely by the utricle and by the passage of the ejaculatory ducts through the substance of the gland.

Pars Membranacea Urethræ.—The membranous part of the urethra is the narrowest and the shortest division of the urethra. It extends from the prostate to the bulb of the urethra, curving gently downwards and forwards, behind the lower border of the symphysis pubis, from which it is distant about 25 mm. (one inch). Its length is barely three-quarters of an inch; and the concavity of its curve is directed forwards and upwards. Throughout its entire length it is enveloped by the fibres of the sphincter urethræ membranaceæ (O.T. compressor urethræ) muscle. Towards its termination the bulbo-urethral glands are placed behind it—one on each side.

The membranous part of the urethra has important relations to the urogenital diaphragm and to the pelvic fascia. As it emerges from the prostate, it pierces the parietal pelvic fascia (*i.e.* the upper fascia of the urogenital diaphragm), and the margins of the aperture through which it passes are carried backwards to become continuous with the sheath of the prostate. At its termination it pierces the inferior fascia of the urogenital diaphragm, about an inch below the symphysis. It lies therefore in the interval between these two fasciæ (Figs. 194, 199, 200).

The mucous membrane of the membranous part of the urethra is directly surrounded by a thin coat of erectile tissue, and that is embraced by a muscular tunic composed of involuntary fibres arranged circularly.

Pars Cavernosa Urethræ (O.T. Spongy Portion of Urethra).—The cavernous portion is the longest division of the urethra.

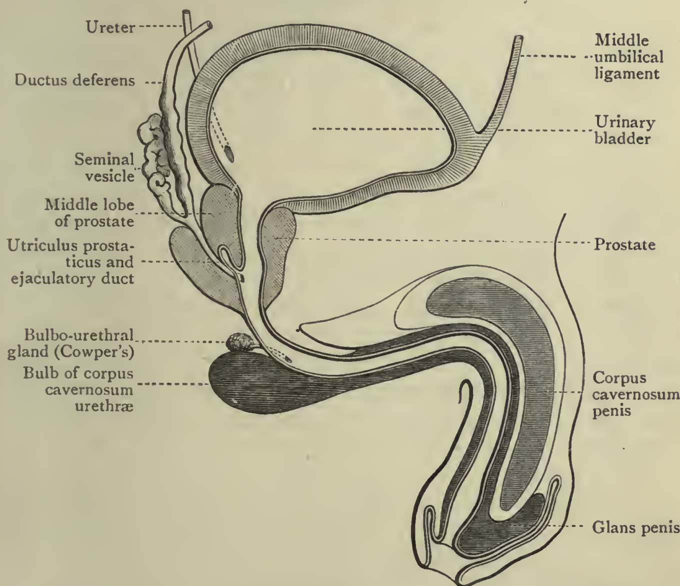


FIG. 203.—Diagram of the Bladder, Urethra, and Penis. (Délépine.)

It is embedded in the substance of the corpus cavernosum urethræ, and its calibre varies considerably at different points. In each expansion of the corpus cavernosum urethræ, viz., the bulb posteriorly and the glans anteriorly, there is a corresponding dilatation of the urethra (Fig. 202); between the dilatations the canal is of uniform diameter, and slightly wider than the membranous portion. The dilatation of the urethra in the glans is termed the *fossa navicularis*. At its orifice, the *external urethral orifice*, the canal is much contracted, and is even narrower than any part of the membranous portion, The orifice is a vertical slit, and its lower end is connected with the prepuce by a fold of skin, termed the *frenulum præputii.*

In the bulb and in the glans penis the erectile tissue of the corpus cavernosum urethræ is disposed very unequally around the urethra. In the bulb it is massed chiefly below or behind the tube, whilst in the glans it is placed chiefly in front and on each side, a very thin layer lying posteriorly.

The ducts of the bulbo-urethral glands (O.T. Cowper's) pierce the floor and open into the cavernous part of the urethra about 25 mm. (one inch) in front of the inferior fascia of the urogenital diaphragm (Figs. 202, 203). The orifices are minute and difficult to find, but by making a small hole in the wall of the duct, as it emerges from the gland, and passing a fine bristle along it, the dissector may be able to find the opening in the urethral floor. After piercing the inferior fascia of the urogenital diaphragm the ducts proceed forwards, first in the erectile tissue, and then in the submucous layer, towards their terminations.

The walls of the urethra are always in apposition except when urine is flowing through it, and a transverse section through the spongy portion, except at its anterior part, has the appearance of a transverse slit. In the fossa navicularis, however, the slit becomes vertical, showing that there the side walls are in contact.

Mucous Membrane of the Urethra.—The mucous lining of the urethra is continuous posteriorly with that of the bladder, and anteriorly with the integument of the glans penis. It is continuous also with the mucous membrane of the various ducts which open into the urethra. Scattered over its whole surface are the mouths of numerous minute recesses, called *lacunæ urethrales.* As a general rule, their openings are directed forwards, and they are largest on the dorsal wall, where some are large enough to catch the point of a small catheter or bougie, especially the lacuna magna, which is situated in the posterior part of the glans penis.

Direction of the Urethral Canal.—The prostatic portion is directed downwards and very slightly forwards. The membranous part describes a gentle curve behind the symphysis. The concavity of the curve looks forwards and upwards. The cavernous part first ascends, and then curves downwards. The urethra, therefore, in the flaccid condition of the penis, takes a course in which there are two curves, like the letter S placed on its side. When the penis is raised towards the front of the abdomen the curve in the cavernous part of the canal is obliterated, and there is then only one curve, the concavity of which is directed upwards.

Dissection.—Divide the peritoneum along the junction of the superior surface with the fundus of the bladder, and extend the incision to the side wall of the pelvis, to separate each lateral false ligament from the peritoneum posterior to it. Next, divide the peritoneum in the median plane on the superior surface of the bladder and then divide the superior and posterior walls of the viscus in the median plane. After the division is completed dissect the fundus of the bladder from the deferent ducts and the seminal vesicles, taking care not to injure the ureters as they enter the bladder wall. When the separation is completed note the relations of the bladder and ureters to the more posterior structures.

In the median plane there may be a slight interval between the deferent ducts in which the rectum is separated from the bladder wall merely by the recto-vesical fascia ; that interval, if it is present, corresponds to the middle and upper part of the trigone of the bladder. On each side of it the deferent duct and the seminal vesicle separate the bladder from the anterior surface of the rectum, and, still more laterally, the apical part of the seminal vesicle lies on the levator ani at the side of the rectum, while the lower part of the ureter intervenes between the vesicle and the bladder wall.

Dissection.—The anterior part of the prostate was divided when the urethra was opened. The dissector should now divide the posterior part in the median plane. The rectum must then be divided in the median plane, and afterwards the sacrum and coccyx must be divided vertically by a saw-cut, to the left of the middle sacral artery. The separation of the two halves of the pelvis from each other must be completed by the division of any remaining soft parts with the knife. All the subsequent stages of dissection and the examination of the relations of the viscera can be quite conveniently carried out on each side separately.

Relations of Blood Vessels and Nerves to the Pelvic Fascia.—The dissector should again note that the blood vessels of the pelvis are placed on the peritoneal surface of the pelvic fascia. It follows, therefore, that all the branches pierce the fascia as they pass to the viscera enclosed in the fascia or as they pass out of the pelvis, and they carry with them prolongations of the fascia which blend with their sheaths. There is one exception to the rule, viz., the obturator artery, which passes over the upper border of the parietal pelvic fascia into the obturator canal. The nerves lie outside the fascia, and, *with the exception of the obturator nerve*, those which are leaving the pelvis do not require to pierce the fascia, but the branches which are to supply the viscera pass through its substance to gain their terminations, and the obturator nerve pierces it posteriorly to gain the interior of the pelvis. The difference between the nerves and blood vessels can be well studied by an examination of the fascia as it passes over the greater sciatic foramen.

The relation of the pelvic blood-vessels to the lining fascia is a matter of some practical importance. The margins of the apertures in the fascia through which the vessels pass are usually strengthened by some encircling fibres; still, a portion of gut may make its way through one or other of the openings in the fascia and form a hernia. Sciatic hernia consists of a protrusion of the gut through the greater sciatic foramen. The hernia may be situated either above or below the piriformis. In the former case it escapes through the aperture in the fascia made by the superior gluteal artery, and in the latter, either through the aperture for the inferior gluteal artery or through that for the internal pudendal artery.

A hernia may occur through the obturator foramen also (obturator hernia). In that case the gut follows the obturator artery over the upper border of the fascia and through the obturator canal.

Intestinum Rectum.—The rectum is the portion of the large intestine which extends from the termination of the pelvic colon, opposite the middle of the third piece of the sacrum, to the point about 38 mm. (one and a half inches) in front of the tip of the coccyx, that is, to the apex of the prostate in the male, and to the apex of the perineal body in the female. At that point it bends abruptly backwards, pierces the rectal layer of pelvic fascia, and becomes the anal canal.

The rectum is about five inches long. For the greater part of its length it is adapted to the anterior surfaces of the sacrum and coccyx (Fig. 202). It is curved, therefore, with the concavity forwards. Beyond the coccyx, the lower 38 mm. (one inch and a half) of the rectum is supported by pelvic floor, formed by the levatores ani muscles, and by the *ano-coccygeal body*. The ano-coccygeal body consists of a dense mass of fibrous tissue which fills the interval between the coccyx and the anus. It receives the insertion of some of the fibres of the levatores ani muscles. Below the pelvic floor, in the

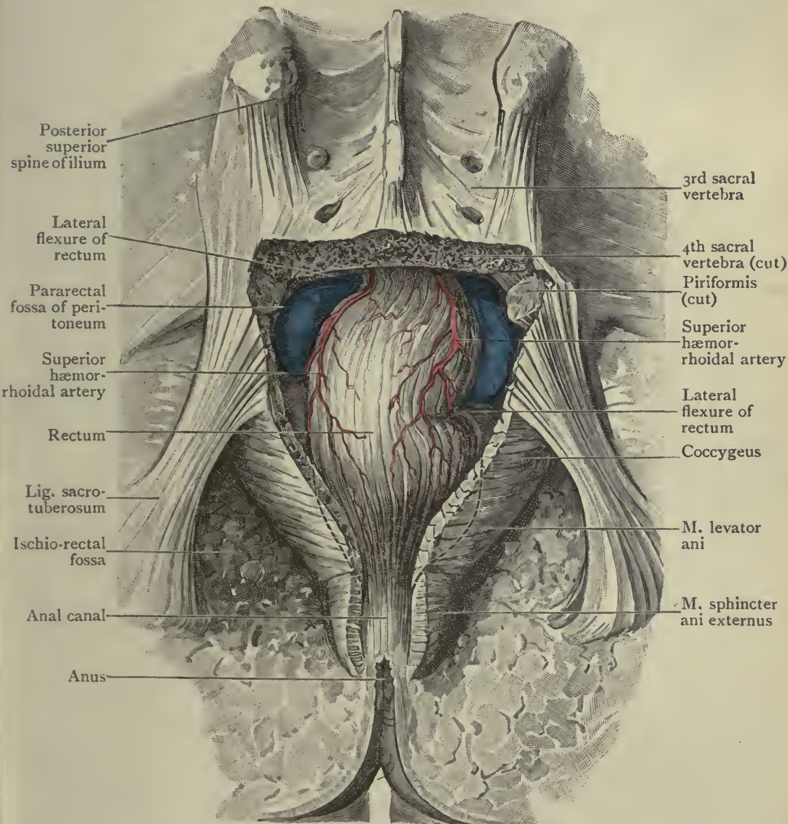


FIG. 204.—Dissection of the Rectum from behind. The sacrum below the 4th sacral vertebra and also the coccyx have been removed. Portions of the levatores ani, coccygei, and external sphincter have also been taken away. (Birmingham.)

region of the ano-coccygeal body, lies the posterior part of the sphincter ani externus muscle.

Peritoneal Relations of the Rectum.—These relations are of practical importance. In its upper third the gut is clothed with the peritoneum both in front and on the sides; then the peritoneum passes away from the sides, so that in its middle third the gut is covered merely in front; finally, about an inch above the base of the prostate, at the bottom of the recto-vesical excavation, the membrane quits the rectum altogether, and is reflected on to the deferent ducts and the

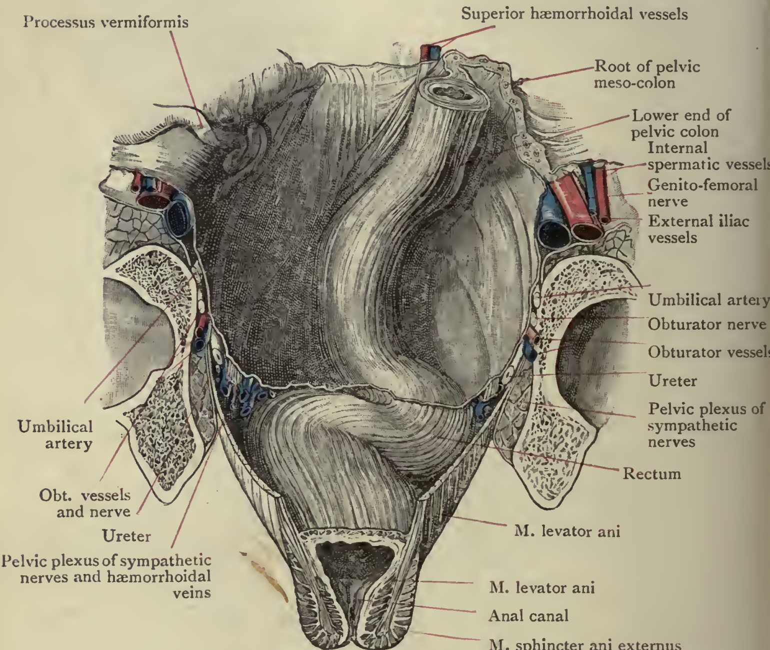


FIG. 205.—Dissection of the Rectum from the front in a specimen hardened by formalin injection. The anterior wall of the pelvis has been removed, and the bladder, prostate, and seminal vesicles have been taken away.

seminal vesicles, as they lie at the fundus of the bladder. The lower third of the rectum is thus altogether devoid of peritoneum. It is separated from the fundus of the bladder and the posterior surface of the prostate by the recto-vesical layer of pelvic fascia; and embedded in the fascia, behind the bladder, are the lower parts of the deferent ducts and the seminal vesicles.

On each side of the upper part of the undistended rectum is a pararectal fossa, and each lateral part of the wall of the lower portion of the gut is supported by the corresponding levator ani muscle (Figs. 196, 204, 205).

Flexures of the Rectum.—The rectum does not take a straight course along the dorsal wall and floor of the pelvis.

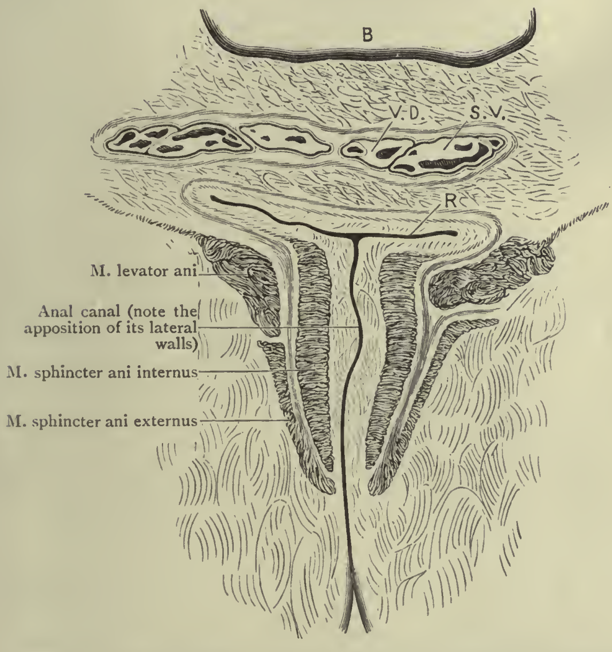


FIG. 206.—Frontal section through the whole length of the Anal Canal. (Symington.)

B. Bladder.
V.D. Ductus deferens.
S.V. Seminal vesicle.
R. Terminal portion of the rectum (note the apposition of its anterior and posterior walls).

On the contrary, it presents three abrupt lateral bends or flexures, of which, as a rule, two are convex to the right and one to the left. The sharply marked infoldings of the wall of the gut opposite the flexures are the cause of the so-called *plicæ transversales recti* (O.T. rectal valves) in the interior of the gut. The flexures are best marked when the gut is distended, but even when it is empty they are usually quite obvious.

The rectum lies between the bladder and prostate in front and the sacrum and coccyx behind, and, when empty, it has its anterior wall pressed against its posterior wall, and in that condition its lumen appears, in transverse section, as a transverse slit (Fig. 206). Behind the apex of the prostate, where the gut bends to become the anal canal, its anterior wall, in the distended condition, sometimes shows a slight bulging *cul-de-sac*, called the *ampulla recti*, which descends to a lower level than the prostate.

Pars Analis Recti.—The anal canal is the narrow slit-like passage, about 38 mm. (one inch and a half) in length, which leads from the rectum to the anal orifice. The canal com-

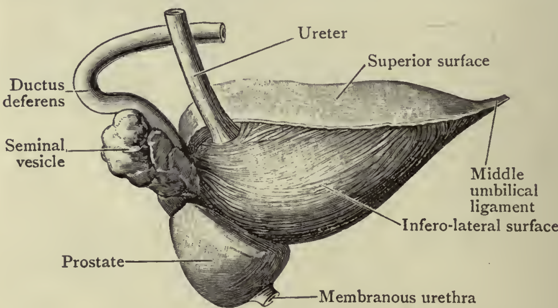


FIG. 207.—Bladder, hardened *in situ*, viewed from the right side. It contained a very small quantity of fluid. (A. F. Dixon.)

mences opposite the apex of the prostate, and proceeds downwards and backwards. It is totally destitute of peritoneum, but it is clothed and supported by a prolongation of the rectal layer of the pelvic fascia, which it pierces. In addition, it is closely surrounded by strong muscles, which keep close guard over it and allow its side-walls to separate from each other only during defæcation. The muscles are:—the *internal sphincter*, developed from the circular muscle of the gut and encircling the canal in nearly its whole length; the *external sphincter*, which surrounds the lower orifice and lower part of the wall; the *levatores ani*, whose medial margins grasp the sides of the canal near its upper end, and pinch in its walls. The membranous part of the urethra and the bulb of the urethra are in front of the canal, but, on account of the backward inclination of the gut, they are separated from it by a mass of fibro-elastic tissue corresponding to the perineal body of the female. Behind the anal canal is the ano-coccygeal body (Symington).

Vesica Urinaria.—The urinary bladder is a hollow viscus, with strong muscular walls, which acts as a temporary reservoir for the urine before it is emitted from the body by the process of micturition. Its form, and, in a great measure, its position and relations, are influenced by the amount of fluid it contains, and by the age of the subject.

The different forms which the bladder assumes, under constantly changing conditions, render its description a matter of serious difficulty. As a rule it is found in the dissecting room with contracted walls and empty. For that reason, and also because our information regarding the empty bladder is more exact, the dissector should study, in the first place, the form it presents when in that condition, and afterwards consider the changes it undergoes as it becomes filled with urine. The following description is based upon the account given by Professor Dixon.

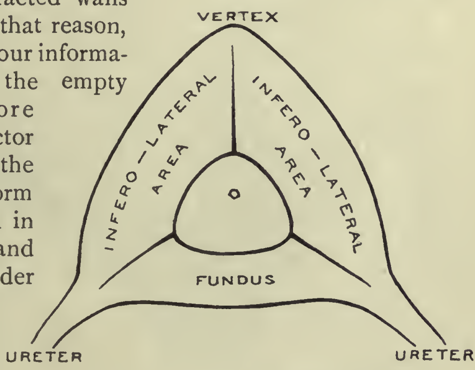


FIG. 208.—Diagram of the Empty Bladder, seen from below. (After A. F. Dixon.)

The *empty bladder* lies completely within the cavity of the pelvis, in the adult. It has the form of a three-sided pyramid, possessing an apex, a base or fundus, and three surfaces, viz.,—a superior surface and two infero-lateral surfaces.

The *fundus* looks backwards towards the rectum, from which it is separated by—(1) the recto-vesical fascia, (2) the deferent ducts and seminal vesicles, which are enclosed in the fascia, and (3) the peritoneum of the anterior wall of the recto-vesical excavation.

The *apex* is placed in relation with the upper part of the symphysis pubis. It is continuous with a strong fibrous cord, the ligamentum umbilicale medium (*urachus*), which proceeds upwards, on the posterior aspect of the anterior abdominal wall, to the umbilicus. The urachus is the remains of the cephalic part of the ventral section of the cloaca of the embryo.

The *superior surface* looks upwards and backwards, and is completely covered with peritoneum. It supports some coils of small intestine and, not uncommonly, a coil of the pelvic colon. It is slightly convex; it is triangular in outline, and is bounded by three borders, viz.—two lateral, which diverge from the apex, and a posterior, which separates it from the base. The lateral and posterior borders meet at the posterior angles, and at those angles the ureters enter the bladder wall.

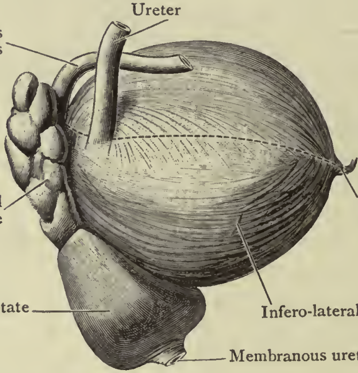


FIG. 209.—Bladder, hardened *in situ*, viewed from the right side. It contained a slightly larger amount of fluid than the specimen depicted in Fig. 207. (A. F. Dixon.)

Each lateral border is in relation with the side-wall of the pelvis, along a line considerably below the level of the deferent ducts and the umbilical artery.

The *infero-lateral surfaces* are separated from each other by a rounded, anterior border. Each infero-lateral surface forms part of the posterior wall of the cave of Retzius, and is separated by extra-peritoneal fat from the back of the body of the pubic bone and the fascia covering the pelvic surfaces of the corresponding obturator internus and the levator ani muscles.

The anterior border, which separates the infero-lateral surfaces, lies behind the symphysis and above and in front of the prostate. It extends downwards and backwards to the internal urethral orifice, which separates it from the lower end of the fundus. It is separated from the back of the symphysis and the pubo-prostatic ligaments by the retro-pubic pad of fat. The retro-pubic pad appears in median sections of the pelvis as a small wedge-shaped mass of soft, fatty areolar tissue (Fig. 210); it is part of the extra-peritoneal fat, and it adapts itself to the changing conditions of the bladder.

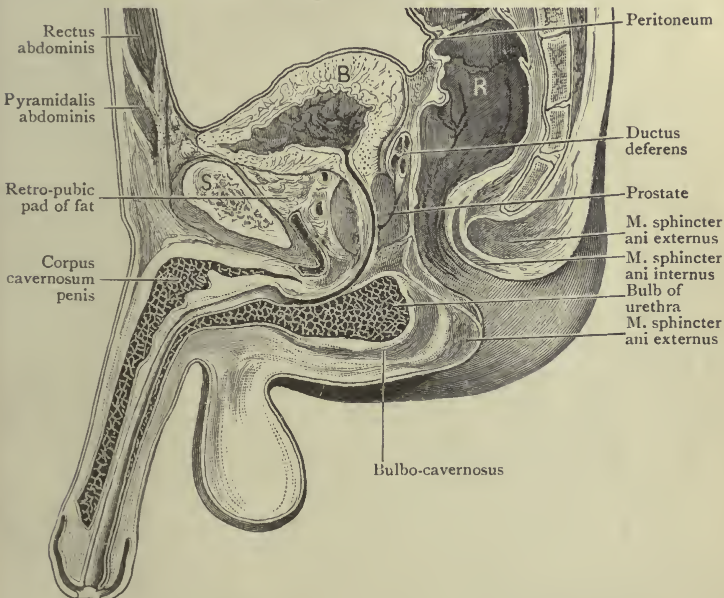


FIG. 210.—Median section through the Pelvis of an Adult Male. The bladder is nearly empty, and the urethra is divided along its whole length.

R. Rectum. S. Symphysis. B. Bladder.

The internal urethral orifice, by which the urine leaves the bladder, is placed at the most dependent part of the bladder, which is situated at the junction of the fundus with the anterior border, in the region termed the *neck of the bladder*. It is surrounded by the base of the prostate, which presents a structural continuity with the bladder wall.

Changes in the form of the Urinary Bladder as it becomes

filled with Urine.—The neck of the bladder is firmly fixed in position by its attachment to the prostate and by its connection with the upper fascia of the pelvic diaphragm, and the prostate is securely held in place by its strong sheath of pelvic fascia; therefore, as the bladder becomes filled, the internal urethral orifice suffers very little change of position. It is only in cases of excessive distension that any marked change in its level becomes manifest, and under such circumstances the internal urethral orifice sinks, to a certain extent, in the pelvic cavity.

As the bladder fills, its superior wall is raised from the fundus and infero-lateral walls. All its surfaces are increased in area, and the borders, which in the empty bladder intervene between them, become rounded off and finally obliterated. The organ thus becomes oval in form, and the walls, which are thick and firm in the contracted state, become comparatively thin. The apex appears above the symphysis pubis, and, as distension goes on, the organ rises higher and higher into the hypogastric region until a considerable extent of its wall becomes applied to the abdominal wall above the pubis. The infero-lateral surfaces of the distending bladder encroach on the paravesical fossæ, and finally obliterate them, thus coming into contact with a greater extent of the side walls of the pelvis.

When the bladder is excessively distended it assumes a spherical form or, in some cases, an ovoid form, with the large end above (Figs. 202, 211). In the latter case its long axis is no longer horizontal, but oblique, being directed from above downwards and backwards.

When the urine is ejected from the bladder, the superior wall descends till it becomes approximated to the infero-lateral walls and the fundus. The viscus, therefore, becomes flattened from above downwards, and comes to lie again entirely within the cavity of the pelvis minor. When such a bladder is examined in a median section, in a subject from whom the urine was expelled shortly before death, the walls of the bladder are thick and firm, and the lumen of the viscus may be reduced to a mere slit. The part of the lumen which lies behind the internal urethral orifice is called the posterior limb, and the part in front of the orifice, bounded by the approximated superior and infero-lateral walls, is called the anterior limb of the cavity. The anterior limb is long and nearly horizontal. The posterior limb is short and sometimes barely recognisable; further, it is oblique or vertical, and joins the anterior limb at an angle. Viewed in median section, therefore, the lumen of the perfectly empty bladder usually forms two limbs of a Y, the stem being the urethra.

In other cases the empty bladder is firm and rounded,

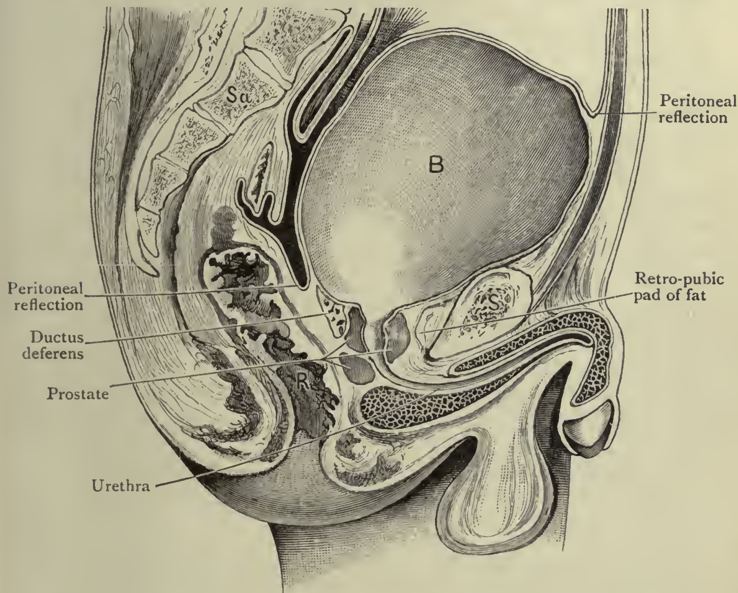


FIG. 211.—Median section through a Male Pelvis in which the Bladder was greatly distended.

B. Bladder. S. Symphysis pubis.
R. Rectum. Sa. Sacrum.

and when divided in the median plane its cavity appears as a single slit, which is directly continuous with the urethra.

Relation of the Peritoneum to the Urinary Bladder.—In the empty bladder only the superior surface is directly covered with peritoneum. The membrane is separated from the upper part of the fundus by the seminal vesicles and the deferent ducts. The infero-lateral surfaces are entirely devoid of peritoneum.

When the bladder fills it rises into the hypogastric region, and it is important to note that the peritoneal reflection from the apex is raised along with the organ, and, as a result, a considerable area of the bladder wall, below the ligamentum umbilicale medium (*urachus*), becomes applied directly to the anterior abdominal wall, no peritoneum intervening. Consequently, in those cases of retention of urine in which a catheter cannot be passed into the bladder through the urethra, relief can be given, without fear of injuring the peritoneum, by puncturing the bladder, with a trocar and cannula, immediately above the symphysis pubis in the median plane (Figs. 202, 211).

Laterally, also, the line of peritoneal reflection is raised until it may appear to leave the lateral border of the bladder along the line of the ductus deferens, as the duct passes backwards along the side wall of the pelvis, or even as high as the level of the umbilical artery.

Posteriorly, the sacro-genital folds are opened out and obliterated to provide a covering for the expanding basal portion of the bladder, but the level of the reflection of the peritoneum which forms the bottom of the recto-vesical excavation undergoes no change. When the rectum is distended the recto-vesical reflection assumes a higher level, but that is not due to any change in the position of the peritoneum in relation to the bladder, but to the entire bladder, with the reflection, being pushed upwards and forwards by the expanding gut.

The Urinary Bladder in New-Born Children.—In the new-born infant the bladder differs both in form and in position from the bladder of the adult. It is more or less piriform, the narrow end passing into the urethra, and there is little or no appearance of a basal portion (Fig. 212). Further, it is placed very much higher. The internal urethral orifice is at the level of the upper border of the symphysis pubis, and the antero-lateral surfaces of the organ, devoid of peritoneum, lie in direct contact with the abdominal wall (Symington). As growth goes on the urethral orifice sinks rapidly from the period of birth up to the fourth year, and more slowly from that period up to the beginning of the ninth year. Then it remains stationary till puberty, after which it sinks slowly till it attains its normal adult position (Disse). It should be noted also that the recto-vesical reflection of peritoneum, in the infant at birth, is at the level of the base of the prostate, which, at that period, is relatively little developed.

Ureters in the Pelvis Minor.—Having crossed the lower end of the common iliac artery, or the upper end of the external iliac artery, at the brim of the pelvis minor, each ureter descends, along the front of the hypogastric artery and its anterior division, till the level of the visceral layer of the pelvic fascia is reached, *i.e.*, the level of the spine of the ischium. It then turns medially and forwards on the upper surface of the visceral fascia. In that part of its course it passes below to the deferent duct (Fig. 192), pierces the vesical layer of the visceral fascia, and enters the bladder

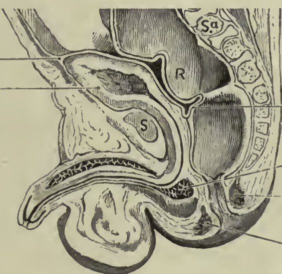


FIG. 212.—Median section through Pelvis of a newly-born full-time Male Infant.

R. Rectum. Sa. Sacrum. S. Symphysis pubis.

wall at the corresponding posterior angle, immediately in front of the upper end of the seminal vesicle. Its point of entry into the bladder wall is about 37 mm. (one and a half inches) above the base of the prostate, and about 50 mm. (two inches) from its fellow of the opposite side. It is covered on its anterior and medial surfaces by the peritoneum, which it raises into a ridge, and the peritoneal-covered surfaces are in relation, on the right side, with coils of small intestine, and, on the left side, with the pelvic colon. To its lateral side, from above downwards, lie the umbilical artery, the obturator nerve, the obturator artery, the inferior vesical artery, and, occasionally, the middle hæmorrhoidal artery, but that vessel may pass behind the ureter.

The obturator vein, which lies at a lower level than the artery, may pass either lateral to or medial to the ureter, on its way to the hypogastric vein. As a rule there is no vein with the superior vesical artery. The veins which correspond to the inferior vesical and middle hæmorrhoidal arteries are irregular in number and large in size; they emerge from venous plexuses on the walls of the respective viscera, and enclose the lower part of the ureter in tortuous coils as they pass to the hypogastric vein.

Prostata.—The prostate is a solid body, partly glandular and partly muscular, which embraces the neck of the bladder and surrounds the first part of the urethra.

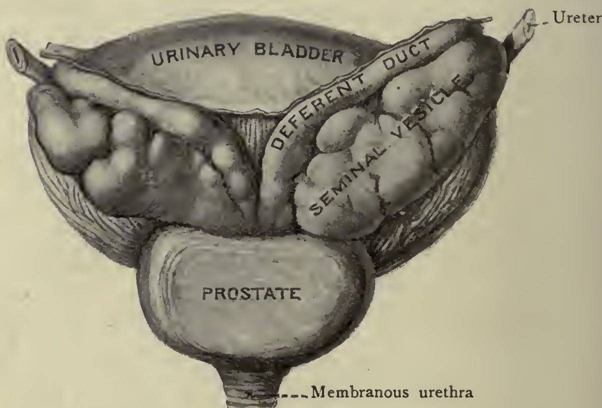


FIG. 213.—Basal aspect of Bladder, Seminal Vesicles, and Prostate, hardened by formalin injection.

It is conical in shape, with its base directed upwards and its apex downwards. In size it is variable, but its average dimensions are: *length*, about 31 mm. (one and a quarter inches) from base to apex; *breadth*, 38 mm. (one and a half inches) from side to side at its broadest part.

Position.—The prostate rests upon the anterior aspect of the lowest part of the rectum. Its apex is about 38 mm. (one inch and a half) distant from the anus, whilst its anterior border lies 18 mm. (three-quarters of an inch) behind the lower part of the symphysis pubis. As already mentioned, the prostate is enclosed in a strong fibrous *sheath*, derived from the pelvic fascia. The fascial sheath is firmly fixed not only by the pubo-prostatic ligaments, which form a part of it, but also, at the apex of the gland, by the continuity which is established between the sheath and the upper fascia of the urogenital diaphragm. The connections of the sheath prevent the prostate altering its position in response to the continual changes which occur in the state of the distension of the bladder. It is a matter of importance to notice that the prostate lies loosely in its sheath. Only in the median

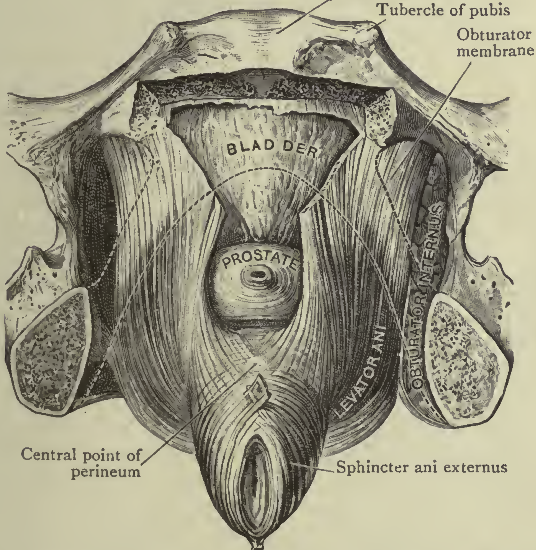


FIG. 214.—Dissection of the two Levatores Ani. The lower part of the pelvis is tilted forwards and the pubic arch has been removed. Both fasciæ of the urogenital diaphragm, the parts in relation to them, and the pubic origins of the levatores ani, have also been taken away. The portion of bone removed is indicated by the dotted lines.

plane, in front, and around the urethra as it emerges from the gland, is there any degree of adhesion between the prostate and its fascial envelope.

Within the sheath, and attached more closely to its inner surface than to the prostate, is a plexus of thin-walled veins, called the *pudendal plexus* (Fig. 199). The plexus is spread over the anterior border and the lateral surfaces of the prostate, and is denser in the latter situations than in the former. It receives the dorsal vein of the penis; it communicates with the internal pudendal vein, and it becomes continuous above, at the base of the prostate, with the prostatico-vesical venous plexus, from which the blood is drained by the inferior vesical veins.

Immediately surrounding the prostate, and quite independent of the sheath, is the fibrous *capsule* of the prostate. The fibrous capsule varies in thickness, in some cases being extremely thin and in others forming a distinct cortex. In association with operations for the removal of the prostate, now frequently performed, it is important to notice that the capsule has but very slight connection either with the venous plexus or with the sheath of pelvic fascia. It is on that account that the gland can be so easily shelled out from its surroundings.

The prostate presents for examination a *base* or superior surface, an *apex* or inferior extremity, a *posterior surface*, two *lateral surfaces*, and an *anterior*, *rounded border*. The *base* looks upwards. It surrounds the internal urethral orifice, and, in a considerable part of its extent, is structurally continuous with the bladder. Around the greater part of its circumference, however, it is separated from the bladder by a groove in which is lodged a group of thin-walled veins, known as the *prostatico-vesical plexus*. The *apex* abuts against the upper fascia of the urogenital diaphragm (Fig. 200). The posterior surface is usually a flat triangular area which rests on the anterior aspect of the rectum, but, occasionally, it is marked by a median, vertical groove. The two lateral surfaces rest upon the levatores ani muscles, and are separated from each other by the prominent, rounded, anterior border, from which the urethra emerges immediately above the apex of the gland.

The delicate ejaculatory ducts pierce the base of the prostate a short distance behind the internal urethral orifice of the bladder, and, as they descend, through the substance of the prostate, they separate the so-called middle lobe from the remainder of the gland, which is generally spoken of as consisting of two lateral lobes, though there is no structural demarcation between them.

The blood-supply of the prostate is derived from the inferior vesical and middle hæmorrhoidal arteries.

Vesiculæ Seminales.—The two seminal vesicles lie between the fundus of the bladder and the rectum. Each is about 50 mm. (two inches) in length and is piriform in shape.

The lower, pointed end of each vesicle rests on the base of the prostate, and the blunt, upper end lies in the sacro-genital fold of peritoneum, in relation with the recto-vesical excavation of peritoneum, and with the entrance of the ureter into the bladder. At their lower extremities the vesicles are separated from each other only by the interposed deferent ducts, but they diverge as they ascend, and their upper ends are wide apart. They are enclosed, together with the deferent ducts, which lie along their medial sides, in a dense sheath derived from the recto-vesical layer of the visceral pelvic fascia.

FIG. 215.—Horizontal section through the Bladder and Rectum at the level at which the ureters enter the bladder.

Each vesicula seminalis is in reality a tube, 12.5 to 15 cm. (five or six inches) long. It is bent repeatedly upon itself and is bound into vesicular form by the dense areolar tissue in which it is embedded. When it is unravelled, several blind diverticula will be found to proceed from the main tube. The lower end of the tube, which is called the *excretory duct*, emerges from the pointed lower end of the vesicle and joins with the ductus deferens, at an acute angle, to form the *ejaculatory duct*.

Ductus Deferens (O.T. **Vas Deferens**).—The deferent duct, or duct of the testis, was previously traced to the abdominal inguinal ring (p. 237), through which it enters the abdomen.

At the abdominal inguinal ring it separates from the other constituents of the spermatic cord, hooks, medially, round the inferior epigastric artery, and descends on the medial side of the external iliac vessels into the pelvis minor. It then runs backwards, on the side wall of the pelvis, immediately external to the peritoneum, through which it is clearly visible, and it crosses, in turn, the umbilical artery, the obturator nerve, the superior vesical artery, and the ureter. Immediately beyond the ureter it turns sharply medially towards the fundus of the bladder, enters the pelvic fascia, comes into relation with the blunt, upper end of the seminal vesicle, and runs downwards and medialwards, in close apposition with the upper or medial side of the vesicle, to the base of the bladder. There, lying close to the median plane, and to its fellow of the opposite side, it turns vertically downwards to the base of the prostate. The lower part of the duct is dilated, tortuous, and sacculated, and is termed the *ampulla*, but its lower end narrows greatly and joins with the duct of the seminal vesicle to form the ejaculatory duct.

Ductus Ejaculatorius.—The ejaculatory duct is formed, immediately above the base of the prostate, by the union of the excretory duct of the seminal vesicle with the termination of the ductus deferens. Its walls are thin and delicate; it is therefore easily torn. Its length is about 18.6 mm. (three-quarters of an inch), and it descends, through the substance of the prostate between the middle and lateral lobes, to the corresponding margin of the opening of the prostatic utricle, where it opens into the prostatic part of the urethra.

Triangle on the Base of the Bladder.—It is customary to describe a triangle at the base of the bladder, bounded laterally by the deferent ducts, and above by the reflection of the peritoneum at the bottom of the recto-vesical excavation. When the pelvic viscera are hardened *in situ*, by formalin injection, such a space can hardly be said to exist, owing to the approximation of the ampullæ of the deferent ducts, but it is possible that when the bladder is distended the space between the deferent ducts may be increased.

Dissection.—The peritoneum has already been lifted up and the extraperitoneal fat removed to show the visceral branches of the hypogastric artery. The pelvic fascia must now be removed and the remaining branches of the hypogastric artery and the accompanying veins must be followed, so far as they lie in the pelvis. Accompanying the arteries a number of nerve twigs from the pelvic plexuses, and from the third and fourth sacral nerves, should be noticed and preserved. As the dissector approaches the posterior pelvic wall he must pull the rectum forwards, and as he does that he should note that branches from the sympathetic trunk and from the third and fourth sacral nerves pass to its walls. Whilst the pelvic fascia is being

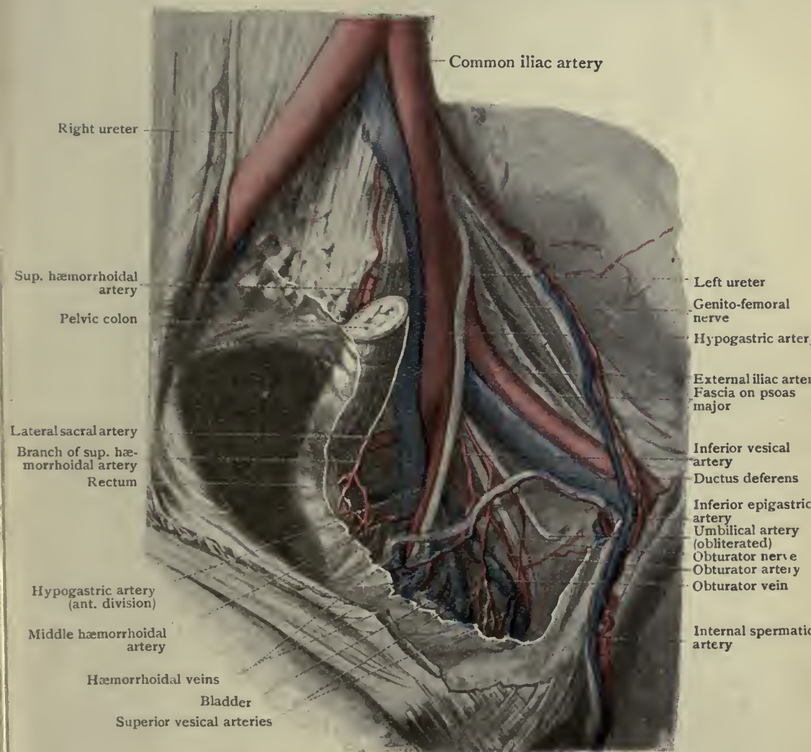


FIG. 216.—The Structures exposed in the left half of the Pelvis Minor by the removal of the peritoneum and extraperitoneal fat.

removed from the sacral region care must be taken not to injure the pudendal and coccygeal plexuses and their roots and the sympathetic trunk, which all lie immediately behind the fascia. The lateral sacral arteries will serve as useful guides, for as they run medially, from the posterior division of the hypogastric artery, they lie in front of the sacral plexus, and as one or other of them descends along the front of the sacrum it lies immediately to the lateral side of the sympathetic trunk and in front of the roots of the sacral nerves as they issue from the anterior sacral foramina.

Pelvic Blood-Vessels.—The pelvic arteries, in the male, are the following:—

1. The hypogastric and its branches (upon each side).
2. The middle sacral } (near the median plane).
3. The superior hæmorrhoidal } (near the median plane).

Arteria Hypogastrica (O.T. **Internal Iliac Artery**).—Each hypogastric artery is the medial terminal branch of the corresponding common iliac artery; it is a short, wide vessel, about 38 mm. (one and a half inches) long, and it is smaller in the adult than the external iliac artery. It commences opposite the sacro-iliac articulation, at the level of the lumbo-sacral articulation; it runs downwards and backwards in the pelvis, and ends, near the upper border of the greater sciatic notch, by dividing into an anterior and a posterior division.

Relations.—To its *lateral side* are the obturator nerve, and, at a higher level, the external iliac vein, which separates it from the medial border of the psoas major (Figs. 216, 224). In *front* is the ureter, and *behind* is the hypogastric vein (Fig. 216). *Medially*, it is covered by peritoneum, which separates the right artery from coils of the ileum, and the left from the pelvic colon. In the female the ovary and the ovarian end of the uterine tube are anterior relations of the artery and of the ureter, from both of which they are separated by the parietal peritoneum.

Condition in the Fœtus.—The condition of the hypogastric artery in the fœtus is very different. It is twice as large as the external iliac artery. Instead of terminating at the sciatic notch it runs forwards, and ascends, on the posterior aspect of the anterior abdominal wall, to the umbilicus, through which it passes, in company with its fellow of the opposite side and the umbilical vein. Outside the abdominal cavity the hypogastric arteries enter the umbilical cord, and, twining spirally round the umbilical vein, they reach the placenta, where the impure blood which they carry is brought into relation with the maternal blood.

After birth, when the umbilical cord is ligatured and divided, a portion of each hypogastric artery, from the umbilicus to the sciatic notch, undergoes atrophy, and is ultimately converted into a fibrous cord known as the *lateral umbilical ligament.* The lateral umbilical ligament springs from the lower end of the trunk, or from the anterior division, of the hypogastric artery, and runs forwards on the side wall of the pelvis to the apex of the bladder, whence it ascends to the umbilicus. At the side of the pelvis it lies at a higher level than the obturator nerve, and it passes to the lateral side of the ductus deferens. For about the first 50 mm. (two inches) of its extent it has a small lumen, and from that part one or more superior vesical branches arise.[1]

Branches of the Divisions of the Hypogastric Artery.

Anterior Division.		Posterior Division.	
Parietal.	Visceral.	Parietal.	Visceral.
Obturator. Internal pudendal. Inferior gluteal.	Superior vesical. Inferior vesical. Middle hæmorrhoidal.	Ilio-lumbar. Lateral sacral. Superior gluteal.	None.

Arteriæ Vesicales Superiores.—As a rule there are two or three slender superior vesical arteries which spring from the umbilical artery. They supply the greater part of the superior and infero-lateral surfaces of the bladder, and occasionally one of them gives off the *artery to the ductus deferens*, an extremely slender branch, which can be traced along the deferent duct to the testis.

Arteria Vesicalis Inferior.—The inferior vesical artery is usually of larger size than any of the superior vesical branches. It crosses in front of the ureter and over or under the angular bend of the deferent duct, to reach the base of the bladder, where it ramifies, sending twigs to the bladder, the seminal vesicle, the ductus deferens, and the prostate. It frequently gives off the *artery to the ductus deferens*.

[1] Although the portion of the hypogastric artery of the fœtus which runs from the greater sciatic notch through the umbilicus to the placenta is the direct continuation of the main trunk, it is frequently called the *umbilical artery* and is spoken of as a branch of the hypogastric artery. When this terminology is adopted the lateral umbilical ligament is said to be the remains of the umbilical artery.

Arteria Hæmorrhoidalis Media.—The middle hæmorrhoidal artery may arise independently or in common with the inferior vesical, and it may pass in front of the lower part of the ureter or behind it. It is distributed mainly to the muscular coat of the rectum, where it anastomoses with the superior and inferior hæmorrhoidal vessels. It supplies twigs also to the prostate, the deferent ducts, the seminal vesicles, and the bladder.

Arteria Obturatoria.—The obturator artery runs forwards on the inner aspect of the pelvic wall to the upper margin of the obturator foramen, where it enters the obturator canal. In the pelvis it lies in the extraperitoneal fat below the obturator nerve and above the vein. It gives some small *iliac branches* to the iliac fossa, and a *pubic branch*, which ascends on the pelvic surface of the pubis to anastomose with the pubic branch of the inferior epigastric artery. The anastomosis, if formed, may become converted into either the commencement of the obturator, which then arises from the inferior epigastric, or the commencement of the inferior epigastric, which then arises from the obturator, and, in either case, it may pass to the medial side or to the lateral side of the femoral ring; thus it attains a close relationship with a femoral hernia. (See p. 260.)

Arteria Pudenda Interna (O.T. Internal Pudic Artery).—In the pelvis minor the internal pudendal artery proceeds downwards in front of the piriformis muscle and the sacral nerves. As it leaves the pelvis minor it passes between the piriformis and the coccygeus muscles, and through the lower part of the greater sciatic foramen.

Arteria Glutæa Inferior (O.T. Sciatic Artery).—The inferior gluteal artery is usually the largest branch given off by the anterior division of the hypogastric artery, and, as a rule, it lies behind the internal pudendal. It passes down in front of the piriformis muscle and the sacral plexus, and frequently through one of the loops of the plexus. It leaves the pelvis by passing between the piriformis and coccygeus muscles, and through the lower part of the greater sciatic foramen (Fig. 216).

Arteria Ilio-lumbalis.—The ilio-lumbar artery springs from the posterior division of the hypogastric artery and passes upwards, laterally, and backwards, behind the obturator nerve, the external iliac vessels, and the psoas major muscle, into the iliac fossa, where it divides into lumbar and iliac branches. The *lumbar branch* runs upwards, and terminates in the substance of the quadratus lumborum and psoas major muscles, where it anastomoses with the lower lumbar arteries. It gives off a small *spinal branch*, which enters the vertebral canal through the intervertebral foramen between the fifth lumbar vertebra and the sacrum. The *iliac branch* breaks up into branches, some of which run laterally in the substance of the iliacus and others between that muscle and the bone. One of the latter set enters the nutrient foramen in the iliac fossa. The terminal branches reach the crest of the ilium, where they anastomose with the deep circumflex iliac and lumbar arteries.

Arteria Glutæa Superior (O.T. **Gluteal Artery**).—The superior gluteal artery is the largest branch of the hypogastric artery, and may be regarded as the continuation of its posterior division. Its course in the pelvis is short. It passes backwards, between the lumbo-sacral trunk and the first sacral nerve, and leaves the pelvis minor through the upper part of the greater sciatic foramen, above the piriformis muscle.

Arteria Sacralis Lateralis.—The lateral sacral artery is occasionally a single vessel, but more commonly it is represented by two branches, which run medialwards, in front of the sacral nerves, to the lateral borders of the anterior sacral foramina. The upper of the two enters the first sacral foramen. The lower runs downwards, lateral to the foramina and the sympathetic trunk, and in front of the roots of the sacral nerves, to the tip of the coccyx where it anastomoses with the middle sacral artery. As it descends it sends spinal branches into the anterior sacral foramina. The spinal branches assist the upper artery to supply the membranes and nerve-roots within the canal; then they emerge through the posterior sacral foramina and anastomose with branches of the superior gluteal artery.

Arteria Hæmorrhoidalis Superior.—The superior hæmorrhoidal artery is the direct continuation of the inferior mesenteric artery. It enters the root of the pelvic mesocolon and descends in it as far as the third piece of the sacrum. There it divides into two branches which proceed downwards, one on each side of the rectum. Each of the branches soon breaks up into smaller branches, which range themselves round the gut and pierce its muscular coat about the middle of its length. Within the submucous coat they proceed down to the anal canal, where it is usual to find one within each rectal column (p. 466). The terminal twigs anastomose freely with each other and with branches of the middle and inferior hæmorrhoidal arteries.

Arteria Sacralis Media.—During the dissection of the abdomen the middle sacral artery was seen springing from the back of the termination of the aorta, above the common iliac arteries. It descends in front of the bodies of the lowest two lumbar vertebræ and behind the left common iliac vein. Reaching the sacrum, it continues downwards in the median plane to the tip of the coccyx. It supplies the glomus coccygeum, and, from each side, it gives off small twigs which anastomose with the lateral sacral arteries.

Veins of the Pelvis.—The arrangement of the veins in the pelvis corresponds in great measure to that of the arteries; but there are some important differences, viz.:—

(1) The *deep dorsal vein of the penis*, instead of joining the internal pudendal vein, enters the pelvis and divides into two branches, which join the pudendal plexus of veins.

(2) The *ilio-lumbar* and *middle sacral veins* pour their blood, as a rule, into the common iliac veins.

(3) The veins around the prostate, bladder, and rectum are large and numerous, and form dense plexuses, which communicate freely with each other. The *pudendal* (O.T. *prostatic*) and *prostatico-vesical plexuses* have already been noticed; the blood is drained from them chiefly by the vesical veins. The *hæmorrhoidal plexus* consists of two parts, one in the submucous coat and one on the surface of the gut. It is the latter which is seen in the dissection. The blood is drained from it by three groups of channels, viz., the *superior hæmorrhoidal vein*, which ends in the inferior mesenteric vein; the *middle hæmorrhoidal veins*, which end in the hypogastric veins; and the *inferior hæmorrhoidal veins*, which go to the internal pudendal veins. The hæmorrhoidal plexus is therefore a link between the portal and systemic systems of veins. This is of practical importance in association with the production of hæmorrhoids or piles, which are due to a varicose condition of the hæmorrhoidal veins. The portal vein and its larger tributaries are without valves; consequently, anything which retards the flow of blood through the portal system will react upon the hæmorrhoidal plexus,

cause its distension, and predispose to the formation of hæmorrhoids.

Vena Hypogastrica (O.T. **Internal Iliac Vein**).—Each hypogastric vein is a large venous trunk which lies behind the corresponding hypogastric artery. Its tributaries correspond to the branches of the hypogastric artery, except that the ilio-lumbar vein opens into the common iliac vein.

The Lymph Vessels of the Pelvis Minor.—It is only in rare circumstances that the dissector will be able to display any of the pelvic lymph vessels, but in favourable subjects he will be able to localise some of the pelvic lymph glands. The main groups of lymph glands of the pelvis are (1) the *hypogastric glands*; (2) the *sacral glands*; and (3) the *rectal glands*. The hypogastric glands are situated on the side walls of the pelvis, near the origins of the branches of the hypogastric arteries. They receive lymph vessels from the membranous part of the urethra, the lower part of the bladder, the prostate, the upper part of the anal canal, and the lower part of the rectum. Their efferent vessels pass to glands situated round the common iliac arteries. The sacral glands lie along the medial sides of the anterior sacral foramina. They receive lymph vessels from the adjacent bones and ligaments, from the rectal glands, and from the prostate. Their efferent vessels end in the common iliac glands. The rectal glands, four or five in number, lie in relation with the superior hæmorrhoidal vein and its two main tributaries. They receive lymph from the rectum, and their efferent vessels terminate in the lateral sacral glands.

Dissection.—As soon as the examination of the pelvic vessels is completed the viscera should be drawn as far as possible from the side wall of the pelvis, and any vessels which tend to prevent the movement should be divided; then the pelvic diaphragm should be examined. It is composed of two muscles on each side, viz.—the levator ani and the coccygeus. Both the muscles must be cleaned, and whilst that is being done care must be taken to avoid injuring the fifth sacral and the coccygeal nerves as they pierce the coccygeus near the coccyx.

Mm. Levatores Ani.—The two levatores ani muscles are strong sheets of muscle fibres, which form the anterior and greater part of the pelvic diaphragm. Each has a triple origin. The anterior fibres arise from the back of the pubic bone, between the attachments of the visceral and parietal layers of the endo-pelvic fascia; the posterior fibres arise from the pelvic surface of the ischial spine; the intermediate fibres, constituting the greater part of the muscle, take origin in the angle between the visceral and parietal layers of the pelvic fascia.

Insertion.—The *anterior fibres* pass downwards and backwards. A few of them are inserted into the central point of the perineum; others are inserted into the wall of the anal canal, between the internal and external sphincters; and some join with the *intermediate fibres*, which sweep round into the angle between the posterior wall of the rectum and the upper end of the anal canal, where they unite with their fellows of the opposite side and form a strong muscular collar round the gut; the lower fibres of this group are inserted into the posterior wall of the anal canal between the two sphincters. The *posterior fibres* pass backwards and medially, and are inserted into the median ano-coccygeal raphe, behind the rectum, and into the side of the lower part of the coccyx. The anterior fibres of the muscles of the opposite sides embrace the lateral surfaces of the prostate as they pass backwards, and are frequently called the *levatores prostatæ* (Fig. 214). As the intermediate and posterior fibres pass to their insertions they support the infero-lateral surfaces of the bladder and the lateral walls of the rectum. When the muscle contracts, as a whole, it tends to elevate the pelvic viscera. The fibres inserted into the wall of the anal canal pull that wall upwards over descending fæces, and therefore aid defæcation. The fibres which form the collar-like loop round the angle between the rectum and the anal passage will, on contraction, increase that angle, and tend to prevent the passage of the contents of the rectum into the anal passage.

Mm. Coccygei.—The coccygei muscles are two small triangular sheets of muscle which continue the plane of the pelvic diaphragm posterior to the levator ani. Each *arises* from the pelvic surface of the ischial spine and the adjacent pelvic fascia, and, expanding as it passes medially, it is *inserted* into the margin of the last piece of the sacrum and the anterior surface of the upper part of the coccyx. Its anterior margin is continuous with the levator ani, and its posterior margin is separated from the lower border of the piriformis by the inferior gluteal and pudendal vessels and the sciatic and pudendal nerves, as they pass out of the pelvis.

The Pelvic Nerve Plexuses.—There are three pelvic spinal nerve plexuses, viz., the sacral, the pudendal, and the coccygeal. The former two are situated on the posterior wall of the pelvis in front of the piriformis muscle, and the latter lies on the coccygeus muscle close to the side of the coccyx.

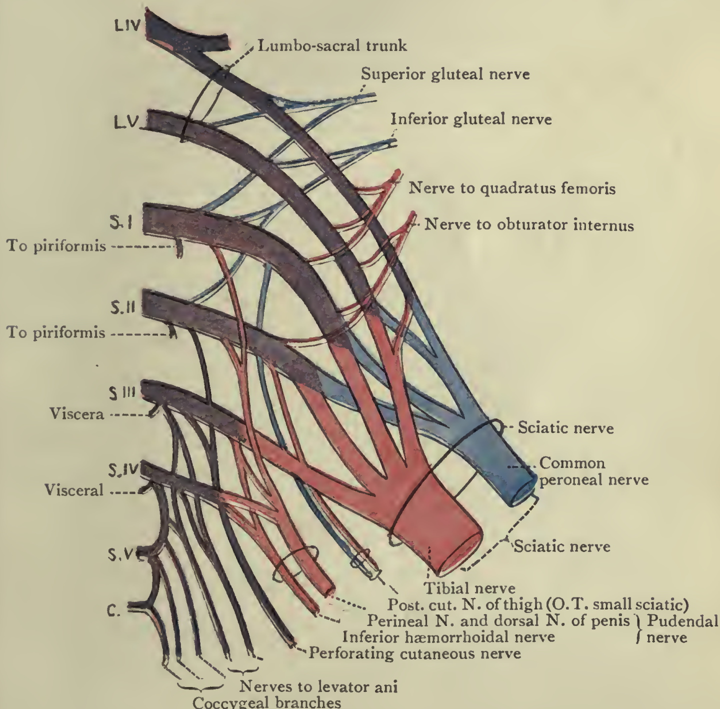


FIG. 217.—Diagram of the Sacral, the Pudendal, and the Coccygeal Plexuses.

The Sacral and Pudendal Plexuses (O.T. **Sacral Plexus**).—The anterior rami of six spinal nerves take part in the formation of the sacral and pudendal plexuses, viz., part of the fourth lumbar nerve, the fifth lumbar, the first, second, and third sacral nerves, and part of the fourth sacral nerve. The first and second sacral nerves are very large, and of about equal size; the third is much smaller, and the fourth still smaller. Each of the anterior rami, before it joins the plexus, receives a branch from the nearest sympathetic ganglion, and the third and fourth sacral nerves give white rami communicantes to the sympathetic pelvic plexuses. By the union of the branch of the fourth lumbar nerve with the fifth lumbar nerve, in the abdomen, a *lumbo-sacral trunk* is formed. It descends behind the common iliac artery and across the brim, into the pelvis minor; there it unites with the first sacral nerve to form a loop through which the superior gluteal artery passes. By the union of the other sacral roots a series of similar loops is formed, and the inferior gluteal artery frequently runs through one or other of them before it leaves the pelvis. Beyond the loops the plexuses usually take the form of two flattened bands, viz.—an upper or *sciatic band* and a lower or *pudendal band*. The *sciatic band* is very large, and consists of the lumbo-sacral trunk with the first sacral nerve and the greater portions of the second and third sacral nerves. It runs downwards and laterally, narrowing but thickening as it descends, and, passing first between the adjacent borders of the piriformis and coccygeus, and then through the lower part of the greater sciatic foramen, it leaves the pelvis and enters the buttock as the sciatic nerve (Vol. I. Fig. 129).

The *pudendal band* is small. It consists of fibres of the second, third, and fourth sacral nerves. It passes between the adjacent borders of the piriformis and coccygeus muscles, and it is continued from the pelvis through the lower part of the greater sciatic foramen as the pudendal nerve.

The student who has already dissected the inferior extremity will remember that the sciatic nerve breaks up into common peroneal (O.T. ext. popliteal) and tibial (O.T. int. popliteal) divisions. It occasionally happens that the two divisions arise separately from the sacral plexus. When that is the case there is no sciatic band, and it becomes evident that the common peroneal nerve is derived from the dorsal divisions of the anterior rami of the fourth and fifth lumbar and the first and second sacral nerves, and the tibial nerve, from the ventral divisions of the anterior rami of the same nerves, and also from the ventral division of the anterior ramus of the third sacral nerve. Moreover, when the common peroneal arises directly from the sacral plexus in the manner indicated, it usually perforates the piriformis muscle on its way out of the pelvis.

In addition to the two main bands into which the sacral and pudendal plexuses resolve themselves (sciatic and pudendal) various other branches are given off, some from the back and some from the front of the plexus. They are :—

1. Superior gluteal.
2. Inferior gluteal.
3. Posterior cutaneous of the thigh (O.T. small sciatic).
4. Nerve to the obturator internus and superior gemellus.
5. Nerve to the quadratus femoris and inferior gemellus.
6. Perforating cutaneous nerve.
7. Branches to the piriformis muscle.
8. Branches to the pelvic viscera.

Nervus Glutæus Superior.—The superior gluteal nerve arises from the posterior aspect of the plexus and contains fibres of the fourth and fifth lumbar and first sacral nerves. It passes, with the superior gluteal vessels, above the upper border of the piriformis muscle, and leaves the pelvis through the upper part of the greater sciatic foramen. It is distributed, in the gluteal region, to the glutæus medius and glutæus minimus, and to the tensor fasciæ latæ muscles.

Nervus Glutæus Inferior.—The inferior gluteal nerve is the special branch of supply to the glutæus maximus. It also springs from the back of the plexus; and it contains fibres of the fifth lumbar and the first and second sacral nerves. It passes below the piriformis and through the greater sciatic foramen into the buttock.

Nervus Cutaneus Femoris Posterior (O.T. Small Sciatic).—The posterior cutaneous nerve arises from the back of the plexus and contains fibres of the second and third sacral nerves. It passes between the piriformis and coccygeus, and leaves the pelvis through the lower part of the greater sciatic foramen.

The Nerve to the Obturator Internus springs from the anterior aspect of the plexus, and contains fibres of the fifth lumbar and the first and second sacral nerves. It leaves the pelvis with the pudendal nerve, and, after giving a twig to the superior gemellus in the gluteal region, it reaches the obturator internus by passing through the lesser sciatic foramen. It sinks into the medial aspect of the muscle.

The Nerve to the Quadratus Femoris springs from the anterior aspect of the plexus, receiving fibres from the fourth and fifth lumbar and the first sacral nerves. It accompanies the sciatic trunk out of the pelvis, and supplies not only the quadratus femoris but also the inferior gemellus and the hip joint.

The Perforating Cutaneous Nerve springs from the back of the plexus and contains fibres of the second and third sacral nerves. It leaves the pelvis by piercing the sacro-tuberous ligament, winds round the lower border of the glutæus maximus, and supplies the skin over the lower and medial part of that muscle.

The Twigs to the Piriformis spring usually from the first and second sacral nerves.

The Visceral Branches (white rami communicantes) are derived mainly from the third and fourth sacral nerves.

Plexus Coccygeus.—The coccygeal plexus is a small, looped plexus. It is formed by the lower branch of the fourth sacral nerve, the fifth sacral nerve, and the coccygeal nerve. Besides joining with the fifth, the *fourth sacral nerve* gives branches to the coccygeus and the levator ani, the latter branch being known as the *perineal branch of the fourth sacral.* It also supplies white *rami communicantes* which join the pelvic plexuses of the sympathetic and supply the pelvic viscera.

The *fifth sacral nerve* enters the pelvis by piercing the coccygeus. It communicates with the fourth sacral and the coccygeal nerves and gives branches to the coccygeus muscle.

The *coccygeal nerve* also enters the pelvis by piercing the coccygeus muscle. Having communicated with the fifth sacral nerve it runs downwards and leaves the pelvis by again piercing the coccygeus muscle. It ends in the skin in the neighbourhood of the tip of the coccyx.

Pelvic Plexuses of the Sympathetic.—It has already been noted that the hypogastric plexus, which lies in front of the last lumbar vertebra, ends below by dividing into the two pelvic plexuses. These are prolonged downwards, one on each side of the rectum. Each pelvic plexus receives numerous branches from the third and fourth sacral nerves and from the pelvic portion of the sympathetic trunk of the same side. The points at which the branches of the sacral nerves and the sympathetic trunk unite with the pelvic plexuses are marked by minute ganglia.

Prolongations from each pelvic plexus are sent along the various branches of the hypogastric artery of the same side. There are thus formed various secondary plexuses, viz.—the *hæmorrhoidal* plexus, distributed to the rectum; the *vesical* plexus, associated with the bladder, the seminal vesicles, and the vas deferens; and the *prostatic* plexus, connected with the prostate. The prostatic plexus proceeds forwards between the prostate and the levator ani, and sends branches, called the *cavernous nerves*, to the penis.

Trunci Sympathici.—The sympathetic trunks reach the pelvis considerably reduced in size. They pass downwards along the medial margins of the anterior sacral foramina, and they end in the median plane, in front of the coccyx, in a minute unpaired ganglion, called the *ganglion impar*. There are generally four ganglia on the pelvic portion of each sympathetic trunk, and each ganglion is connected with one of the sacral nerves by a grey communicating ramus. Some of the branches from the ganglia are distributed to the anterior surface of the sacrum, around the middle sacral artery. From the upper ganglia branches proceed to the pelvic plexuses, and from the ganglion impar branches are given to the parts about the coccyx and to the glomus coccygeum.

Glomus Coccygeum (O.T. **Coccygeal Body**).—This is a lobulated body, about the size of a small pea, which lies in front of the tip of the coccyx. It is composed of masses of polyhedral cells, intermingled with strands of connective tissue, numerous sympathetic nerve twigs, and branches of the middle sacral artery. Its function is unknown.

Dissection.—The vessels and nerves passing to the viscera should be divided and the viscera should be removed, and the structure of the walls of the rectum and bladder should be examined.

Structure of the Rectum.—The rectum possesses the following coats:—1. Serous. 2. Fascial. 3. Muscular. 4. Submucous. 5. Mucous.

The *peritoneal coat*, and the *fascial coat*, derived from the visceral layer of the pelvic fascia, have already been examined.

The Muscular Coats of the Rectum.—The muscular coats of the rectum are strong. They consist of an external longitudinal and an internal circular layer of involuntary or unstriped muscle-fibres. The longitudinal fibres are continuous, above, with the three longitudinal bands of the colon. As the three bands pass downwards the fibres which compose them spread out to form a continuous layer round the rectum.

The layer is not, however, uniformly thick on all aspects of the gut, for in front and on the back the fibres are massed to form two broad bands, which maintain the flexures and prevent the rectum from elongating as it becomes loaded. The circular muscle-fibres form a more or less uniform layer, internal to the longitudinal fibres, and they are prolonged into the bases of the plicæ transversales.

Muscular Coat of the Anal Canal.—The muscular wall of the anal canal is very thick and powerful. The internal circular layer of muscle-fibres, prolonged down from the rectum, is greatly thickened to form a muscular cylinder, the *internal sphincter*, which embraces the whole length of the canal, except the lower 12.5 mm. (half-inch). The longitudinal fibres from the rectum are also prolonged downwards, outside the internal sphincter, and they blend with the fibres of the levator ani, which are inserted into the wall of the canal between the internal and the external sphincters. The external sphincter surrounds the lower part of the canal outside the levator ani.

Submucous Coat of the Rectum and Anal Canal.—The submucous coat is composed of lax areolar tissue, which allows the mucous coat to move freely on the muscular coat. It contains vessels and nerves.

Mucous Membrane of the Rectum and Anal Canal.—The mucous membrane of the rectum and anal canal is thicker and more movable upon the muscular tunic than the mucous membrane of the colon, and, in consequence of its mobility, it is thrown into irregular folds or rugæ when the gut is empty. In the upper part of the anal canal the mucous membrane is thrown into a series of longitudinal folds, called *columnæ rectales* (Morgagni). A short distance above the anal orifice the columns are connected by a number of irregular semilunar folds, called the *anal valves*. In the concavity of each valve is a pocket-like recess, termed a *sinus rectalis*. The folds are of importance in connection with the condition known as fissured anus, and they indicate the level at which the scaly epithelium of the integument merges into the columnar epithelium of the gut.

Plicæ Transversales Recti (O.T. **Valves of Houston**).—The transverse folds of the rectum are not always visible, and are usually seen best in a rectum which has been fixed with formalin when in a state of distension. They are three in number, in conformity with the inflections of the gut;

consequently there are two on the left side and one, the largest, on the right side. Each is formed by an infolding of the mucous, submucous, and part of the muscular coat. The positions of the folds are variable; but the right and largest is usually placed at the level of the bottom of the recto-vesical excavation of peritoneum, whilst the two folds of the left side are situated, one 38 mm. (an inch and a half) above the right fold, and the other the same distance below it (Birmingham).

The Structure of the Walls of the Bladder.—The bladder possesses the following five coats:—

1. Serous. 2. Subserous. 3. Muscular. 4. Submucous. 5. Mucous.

The *serous* or *peritoneal covering* has already been examined. The *subserous coat* is a thin stratum of areolar tissue which connects the peritoneum with the muscular coat.

The Muscular Coat.—The fibres of the muscular wall of the bladder are arranged in three layers:—

1. External longitudinal fibres. 2. Circular fibres. 3. Internal longitudinal fibres.

The *external longitudinal fibres*, frequently spoken of as the *detrusor urinæ*, spring from the back of the pubic bones, the pubo-prostatic ligaments, and the base of the prostate. They ascend from those attachments over the anterior border and the medial parts of the infero-lateral surfaces of the bladder. At the apex a few pass into the urachus, but the majority pass backwards over the superior surface and the base of the bladder to the prostate, to which they are attached. On the lateral parts of the infero-lateral surfaces and on the lateral borders of the bladder, the longitudinal layer is less complete, and the fibres take a more oblique direction.

The *circular fibres* are arranged in coarse bundles which run obliquely as well as circularly round the bladder, and constitute the greater part of its muscular coat. At the internal urethral orifice the bundles become finer and are massed together to form a sphincter, the fibres of which are more or less continuous with those of the prostate.

The *internal longitudinal fibres* are absent on the fundus, and form only an incomplete layer on the other walls of the bladder.

The Submucous Coat.—The submucous coat is a layer of areolar tissue which forms a loose connection between the mucous and muscular coats, except in the region of the trigone, where the connection is much closer. The blood-vessels and nerves ramify in the submucous layer before they enter the mucous coat.

The Mucous Coat.—*The mucous coat* has already been examined (p. 425). When the bladder is distended it is smooth in all areas, but when the bladder is empty or partially empty it is smooth in the area of the trigone only. In all other parts it is thrown into a series of irregular folds (Fig. 200).

Dissection.—Remove the levator ani, leaving small portions attached to its bony origins, viz., the body of the pubis and the spine of the ischium. Take away all the remains of the parietal pelvic fascia from the side wall of the pelvis, and the obturator internus muscle will be exposed.

M. Obturator Internus.—The internal obturator muscle clothes the side wall of the pelvis on its inner aspect. It is fan-shaped and takes an extensive origin, viz.—(1) from the circumference of the obturator foramen, except above, where the obturator vessels and nerves quit the pelvis; (2) from the pelvic surface of the obturator membrane; (3) from the surface of bone behind the obturator foramen, as far back as the greater sciatic notch. A few fibres are derived also from the parietal pelvic fascia which covers it. From these origins the fibres converge towards the lesser sciatic notch, and end in a tendon which issues from the pelvis through the lesser sciatic foramen. In the gluteal region the tendon is inserted, together with the two gemelli, into the medial margin of the upper border of the greater trochanter of the femur. The margin of the lesser sciatic notch over which the tendon glides is coated with smooth cartilage, which is raised into three or four parallel ridges; the ridges fit into fissures in the deep surface of the tendon. A mucous bursa intervenes between the tendon and the cartilage.

The obturator internus is supplied by a special branch from the front of the upper part of the sacral plexus (p. 463). In the erect posture it is a lateral rotator of the femur, but when the hip joint is flexed it is an abductor of the femur.

M. Piriformis.—The piriformis lies on the anterior aspect of the posterior pelvic wall. It *arises* by three processes from the anterior surface of the sacrum, in the region of the second, third, and fourth sacral segments, between and lateral to the foramina and, to a slight extent, medial to the foramina ; it takes origin also from the upper border of the greater sciatic notch and from the sacro-tuberous ligament. The muscle leaves the pelvis through the upper part of the greater sciatic foramen, and is *inserted*, by a rounded tendon, into the middle of the upper border of the greater trochanter of the femur. It is supplied by branches from the first and second sacral nerves. Its actions are the same as those of the obturator internus.

Ligamenta Cinguli Extremitatis Inferioris (Ligaments of the Pelvic Articulations).

The pelvis is attached to the last lumbar vertebra at the lumbo-sacral articulation, and its several parts are held together by the following articulations :—(1) Sacro-coccygeal ; (2) Coccygeal ; (3) Sacro-iliac ; (4) Pubic.

Dissection.—The nerves and blood-vessels of the pelvis, and all adhering portions of muscle, must now be removed from the hip bone and from the front and back of the sacrum. When that has been done the pelvis should be soaked for some time in warm water, a proceeding which will render the dissection of the ligaments much easier.

Lumbo-sacral Articulations. — The last lumbar vertebra is joined to the sacrum by one *synchondrosis*, which connects the body of the vertebra to the base of the sacrum, and by two *diarthrodial joints*, between the two pairs of articular processes.

Articular capsules, consisting of a fibrous stratum lined with a synovial stratum, surround the articulations formed by the apposition of the articular processes.

Ligamenta Longitudinalia (O.T. *Anterior and Posterior Common Ligaments*).—The anterior longitudinal ligament of the vertebral column is continued downwards, over the anterior aspect of the body of the last lumbar vertebra, to the anterior aspect of the first segment of the sacrum. In a similar manner the posterior longitudinal ligament is prolonged downwards, within the vertebral canal, over the posterior aspect of the body of the last lumbar vertebra, to the upper part of that portion of the sacrum which forms the anterior wall of the sacral canal.

Ligamenta Flava (O.T. *Ligamenta Subflava*) also are present. They are two short bands of yellow elastic tissue, placed one on each side of the median plane. Superiorly, they are attached to the anterior aspect of the lower borders of the laminæ of the last lumbar vertebra; whilst, inferiorly, they are fixed to the posterior aspect of the upper margins of the laminæ of the first sacral segment.

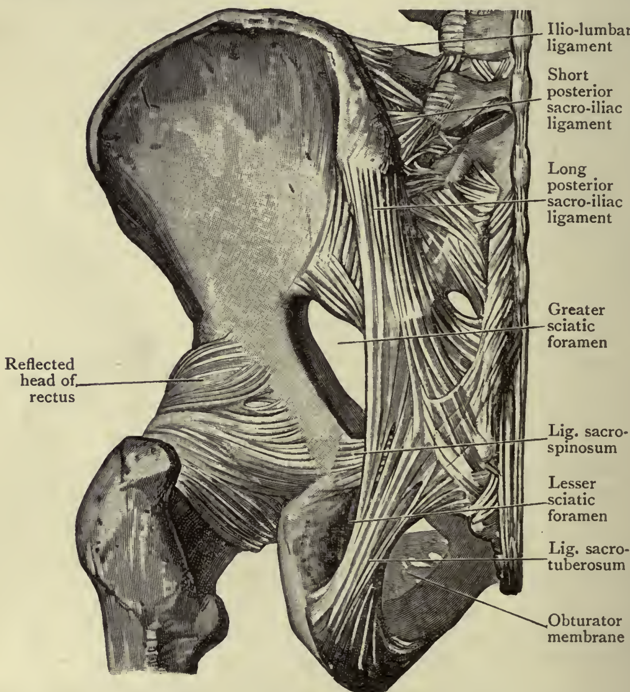


FIG. 218.—Posterior view of the Pelvic Ligaments and of the Hip Joint.

Ligamentum Interspinale.—An interspinous ligament connects the lower border of the spinous process of the last lumbar vertebra with the upper border of the spinous process of the first sacral vertebra. A *ligamentum supraspinale* passes between the extremities of the same spinous processes.

So far, then, the ligaments of the lumbo-sacral articulations are identical with those which, above the level of the sacrum, bind the several segments of the vertebral column together. Two additional ligaments, on each side, viz., the lumbo-sacral and the ilio-lumbar, must now be examined.

The *lumbo-sacral ligaments* are the representatives of the anterior costo-transverse ligaments. Each is a strong, triangular, fibrous band, attached by its apex to the tip and lower border of the transverse process of the last lumbar vertebra. Expanding as it proceeds downwards, it is fixed below to the posterior part of the base of the sacrum, where some of its fibres intermingle with those of the sacro-iliac ligaments.

Ligamenta Iliolumbalia.—Each *ilio-lumbar ligament* may be considered a thickened and specially developed part of the anterior lamella of the lumbar fascia of the corresponding side, for it lies in the same plane as the fascia and is directly continuous with it. It is triangular in shape, and is fixed by its apex to the tip of the transverse process of the last lumbar vertebra. Proceeding horizontally and laterally, it is inserted into the internal lip of the iliac crest, at the posterior part of the iliac fossa.

The *synchondrosis* between the body of the last lumbar vertebra and the base of the sacrum corresponds, in every respect, to the similar articulations between the bodies of the vertebræ above. The opposed bony surfaces are each coated with a thin layer of hyaline cartilage, and are firmly united by an intervening disc of fibro-cartilage, which is dense and laminated externally, but soft and pulpy towards the centre. The dissector should note that the disc is the thickest of the series, and further, that it is wedge-shaped, being thicker in front than behind.

Sacro-coccygeal Articulations.—The sacro-coccygeal articulations are (1) a synchondrosis between the bodies of the last sacral and the first coccygeal vertebra, and (2) a pair of syndesmoses between the sacral and coccygeal cornua. In the synchondrosis between the bodies of the last sacral and the first coccygeal vertebra each of the articulating surfaces is covered with a thin cartilaginous plate, and the cartilage plates are united by a disc of fibro-cartilage. The joint is strengthened in front by an *anterior ligament*, which extends downwards from the front of the sacrum to the anterior aspect of the coccyx, and by a *posterior ligament*, which, attached above to the posterior border of the lower aperture of the sacral canal, proceeds downwards upon the posterior aspect of the coccyx. The posterior ligament is much the stronger of the two. The sacral and coccygeal cornua are united by fibrous bands. Other fibrous bands connect the lateral angles of the sacrum and the transverse processes of the first piece of the coccyx.

As regards the *coccygeal joints* (when such exist), the union of the different segments of the bone is brought about by intervening fibro-cartilaginous discs and anterior and posterior ligaments.

Sacro-iliac Articulation.—The sacrum is wedged in between the two hip bones, and is held fast in that position by the sinuous form of the opposed articular surfaces, and by the strong ligaments which pass between the bones. The ligaments are:—

1. Anterior sacro-iliac.
2. Posterior sacro-iliac.
    (*a*) Long posterior sacro-iliac.
    (*b*) Short posterior sacro-iliac.
    (*c*) Interosseous sacro-iliac.
3. Sacro-tuberous.
4. Sacro-spinous.

Ligamentum Sacroiliacum Anterius.—The anterior sacro-iliac ligament is by no means strong. It is composed of a series of short fibres stretching across the front of the joint, and connecting the bones anteriorly.

Ligamentum Sacroiliacum Posterius Longum.— The *long posterior sacro-iliac ligament* is fixed, above, to the posterior superior spine of the ilium; whilst, inferiorly, it is inserted into the third tubercle on the posterior surface of the lateral mass of the sacrum. It lies posterior to the interosseous ligament.

Ligamentum Sacroiliacum Posterius Breve.— The short posterior sacro-iliac ligament also lies behind the interosseous ligament, and is a short band of fibres which extends from the posterior superior spine of the ilium to the back of the sacrum.

Ligamentum Sacroiliacum Interosseum.— The *interosseous sacro-iliac ligament* is exceedingly strong. It consists of fibrous bands which connect the rough surface on the lateral part of the posterior aspect of the sacrum with a corresponding rough surface on the ilium, behind the auricular surface. Upon the interosseus sacro-iliac ligaments the strength of the articulation chiefly depends. Since the sacrum narrows towards its dorsal surface it cannot be regarded as forming a typical keystone of an arch. On the contrary, it is suspended from the iliac bones by the posterior sacro-iliac ligaments.

Ligamentum Sacrotuberosum (O.T. *Great Sacro-sciatic Ligament*).—The sacro-tuberous ligament has a wide attachment to the posterior superior and posterior inferior iliac spines and to the side of the sacrum and coccyx. As it passes downwards and forwards it narrows and thickens, but before reaching its termination it again expands. It is inserted into the medial border of the tuberosity of the ischium. Thence

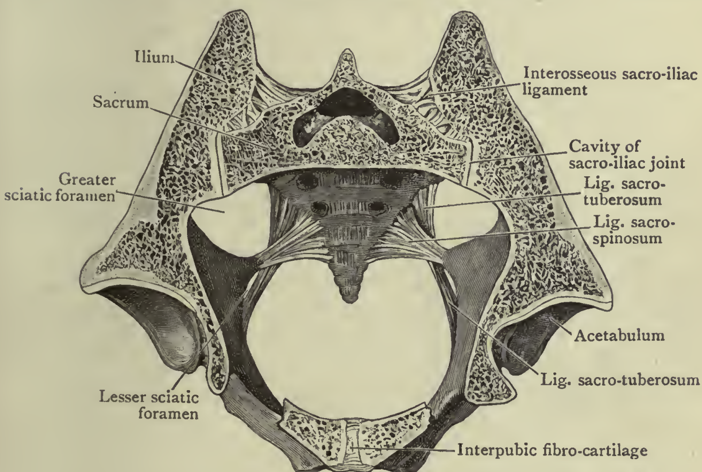


FIG. 219.—Frontal section through the Pelvis.

it sends a sharp *falciform process* forwards for a short distance upon the inferior ramus of the ischium, and gives attachment to the parietal pelvic fascia. It should be noticed that at its ischial attachment some of the fibres of the ligament pass directly into the tendon of the biceps femoris muscle.

Ligamentum Sacrospinosum (O.T. *Small Sacro-sciatic Ligament*).—The sacro-spinous ligament is triangular in form. By its base it is fixed to the side of the sacrum and coccyx, in front of the sacro-tuberous ligament, the fibres of both mingling together; by its apex it is attached to the spine of the ischium. The pelvic surface of this ligament presents an extremely intimate connection with the coccygeus muscle;

indeed, it is generally believed that the ligament is derived from the posterior part of the muscle by the fibrous degeneration of the muscular fasciculi.

The sacro-tuberous and the sacro-spinous ligaments convert the sciatic notches of the hip bone into foramina.

Through the *greater sciatic foramen* pass the superior gluteal vessels and nerve, the piriformis muscle, the pudendal and inferior gluteal vessels and nerves, the nerve to the obturator internus, the sciatic nerve, the nerve to the quadratus femoris, and the posterior cutaneous nerve of the thigh.

The *lesser sciatic foramen* transmits the tendon of the obturator internus muscle, the pudendal vessels and nerve, and the nerve to the obturator internus muscle.

The sacro-iliac joint is a diarthrodial joint. The ligaments of the joint should now be divided, and the two bones forcibly wrenched asunder. It will then be seen that each articular surface is covered with a plate of cartilage, and that a small synovial space intervenes between and partially separates the two plates.

The sacro-iliac joint is not immovable. A slight amount of movement can take place—the sacrum rotating round an imaginary line drawn transversely through its second piece. In the erect posture the promontory of the sacrum is withdrawn to the full extent from the symphysis; when the body is bent forwards, the symphysis and the promontory are approximated, and, in consequence, the tension of the sacro-tuberous and sacro-spinous ligaments is increased.

Symphysis Ossium Pubis.—The symphysis pubis is an example of a synchondrosis. In addition to the intervening disc of fibro-cartilage which connects the cartilage-covered opposing surfaces of the two pubic bones, *four* ligaments are present, viz.:—

1. Anterior pubic. 2. Posterior pubic. 3. Superior pubic. 4. Arcuate.

Ligamentum Pubicum Anterius.—The *anterior pubic ligament* is strongly marked, and consists of two layers of fibres—a superficial and a deep. The *superficial fibres* are oblique, and cross each other like the limbs of the letter X, mingling with the decussating fibres of the superior crura of the subcutaneous inguinal rings. The *deep fibres* are transverse and extend across from one bone to the other.

Ligamentum Pubicum Posterius.—The *posterior pubic liga-*

ment consists of a very few transverse fibres on the pelvic aspect of the joint.

Ligamentum Pubicum Superius.—The *superior pubic ligament*, like the preceding, is weak. It is placed upon the upper aspect of the symphysis, and stretches between the crests of the two pubic bones.

Ligamentum Arcuatum Pubis (O.T. *Sub-pubic Ligament*).—*The arcuate pubic ligament* is situated on the lower aspect of the joint, and it rounds off the apex of the pubic arch. It is a strong band, somewhat triangular in shape, which is attached, on each side, to the inferior ramus of the pubic bone, and above, to the fibro-cartilaginous disc. Between the crescentic lower margin of this ligament and the upper border of the urogenital diaphragm there is an oval aperture through which the dorsal vein of the penis passes backwards.

Dissection.—The saw should now be used, and a portion sliced off from the front of the interpubic joint. The intervening plate of fibro-cartilage can in this way be studied. It will be seen to be thicker and denser in front than behind. As a general rule, a small synovial cavity will be found towards its posterior part, and nearer its upper than its lower end.

Membrana Obturatoria (O.T. Thyroid Membrane).—The obturator membrane stretches across the obturator foramen. It is attached to the circumference of the foramen, except at its upper part, where it bridges across the groove on the inferior surface of the superior ramus of the pubic bone, and converts it into a canal for the escape of the obturator vessels and nerve. At that point it is continuous, over the upper border of the obturator internus muscle, with the parietal pelvic fascia.

Female Pelvis Minor.

The contents of the female pelvis are the following :—

Viscera.
- The pelvic colon and rectum.[1]
- The urinary bladder, the urethra, and the ureters.[1]
- The uterus and vagina.[1]
- The uterine appendages.
  - Uterine tubes.
  - Ovaries.
  - Round ligaments.

[1] Strictly speaking, the urinary bladder and urethra, the vagina and the lower part of the rectum, lie in the visceral layer of the pelvic fascia.

Blood-vessels.	The hypogastric vessels and their branches. The superior hæmorrhoidal vessels. The ovarian vessels. Certain venous plexuses in relation with the viscera.
Nerves.	The obturator nerves. The pelvic plexuses of the sympathetic and their offsets.

Peritoneum and extra-peritoneal fat.

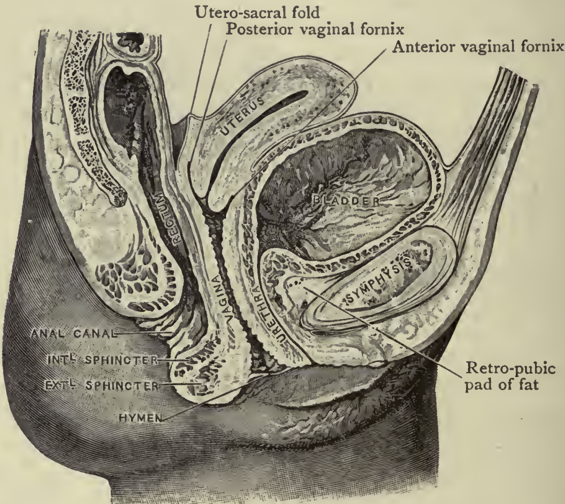


FIG. 220.—Median section through Female Pelvis.

The following structures lie in the wall of the pelvis minor, outside the pelvic fascia :—

Blood-vessels.	The middle sacral vessels. The parietal branches of the hypogastric vessels after they have pierced the fascia.
Nerves.	The sacral, pudendal, and coccygeal plexuses. The pelvic parts of the sympathetic trunks.

General Position of the Viscera.—The *pelvic colon* lies in the posterior and upper part of the cavity, and its loops tend to overlap the other viscera. The *rectum* occupies the posterior and lower part of the cavity, and is adapted to the concavity of the sacrum and coccyx. The *urinary bladder* and *urethra* are situated in front, the former lying against the bodies of the pubic bones. The *uterus* and *vagina* occupy an intermediate position between the urinary bladder and the rectum; and the *uterine appendages* lie laterally between the uterus and the side walls of the pelvis minor.

Peritoneum. — As the peritoneum descends from the posterior abdominal wall into the pelvis, it gives a complete covering to the pelvic colon and attaches it to the anterior surface of the sacrum by a pelvic meso-colon. At a lower level it gives a partial covering to the rectum, first clothing it on its anterior and lateral surfaces, then on its anterior surface alone. Finally, it quits the gut about 7 cm. (three inches) above the level of the anus, and is reflected on to the upper part of the posterior wall of the vagina (Fig. 220), upon which it ascends to the uterus. It covers the whole of the supravaginal portion of the posterior surface of the uterus, the fundus or upper extremity, and the upper two-thirds of the anterior surface of the uterus; then it is reflected on to the fundus of the bladder. As the peritoneum passes forwards from the uterus to the bladder it forms two slightly marked folds, one on each side, which are called the vesico-uterine folds. The vagina, therefore, receives a partial covering of peritoneum posteriorly, but is altogether devoid of peritoneum anteriorly. The whole of the supravaginal portion of the posterior surface of the uterus is covered, but only the upper two-thirds of the anterior surface. From each lateral border of the uterus the peritoneum extends laterally in the form of a wing-like fold, the *broad ligament*, which connects the uterus with the side wall of the pelvis.

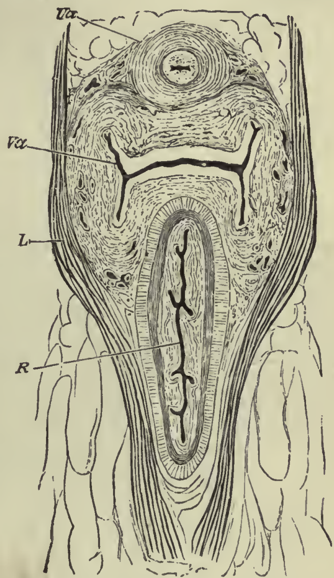


FIG. 221.—Horizontal section through the Urethra, Vagina, and Anal Canal, a short distance above their terminations. (Henle.)

Ua. Urethra. | *L.* Levator ani.
Va. Vagina. | *R.* Rectum.

From the upper surface of the bladder the peritoneum is conducted upwards to the posterior surface of the anterior abdominal wall by the middle umbilical ligament, over which it forms a fold known as the *median umbilical fold.* From each lateral border of the upper surface of the bladder the peritoneum extends laterally to the side wall of the pelvis, forming the *lateral false ligaments of the bladder.*

Ligamenta Lata Uteri (Broad Ligaments of the Uterus).—Each broad ligament is a wide fold composed of two layers of peritoneum. It stretches from the lateral border of the uterus to the side wall of the pelvis, and may be said to possess superior, inferior, medial and lateral borders, and

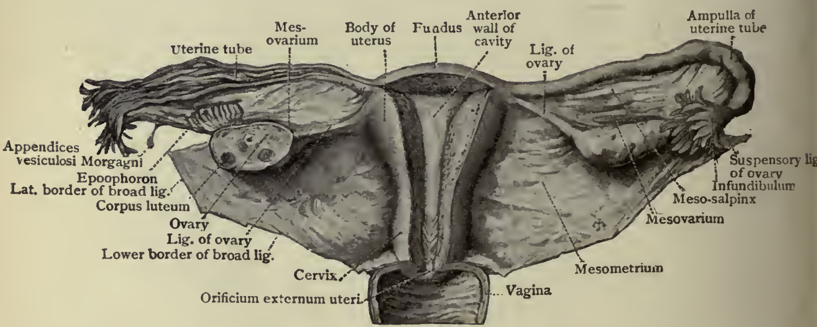


FIG. 222.—The Uterus, the Uterine Tubes, the Ovaries, the Broad Ligaments, and the upper part of the Vagina, seen from behind. The posterior wall of the uterine cavity has been removed, and the left Uterine Tube and the upper part of the Vagina have been opened.

anterior and posterior surfaces. The *superior border* is free, and, in the greater part of its extent, it encloses the uterine tube. The smaller lateral part of the superior border which extends beyond the uterine tube is called the *suspensory ligament* of the ovary; it contains the ovarian vessels and nerves. The *inferior border or base* rests, medially, on the upper end of the vagina and, laterally, on the levator ani. At the lower border, the anterior layer of the peritoneal fold is reflected forwards, to become continuous with the lateral false ligament of the bladder, and the posterior layer passes backward into the floor of the genital or middle pelvic fossa. The *lateral border* of the ligament is attached to the side wall of the pelvis, a short distance in front of the hypogastric artery. The *medial border* is attached to the side of the uterus.

Two secondary folds spring from the broad ligament, one from each surface. The one from the posterior surface contains the *ovary and its ligament*, and the one from the

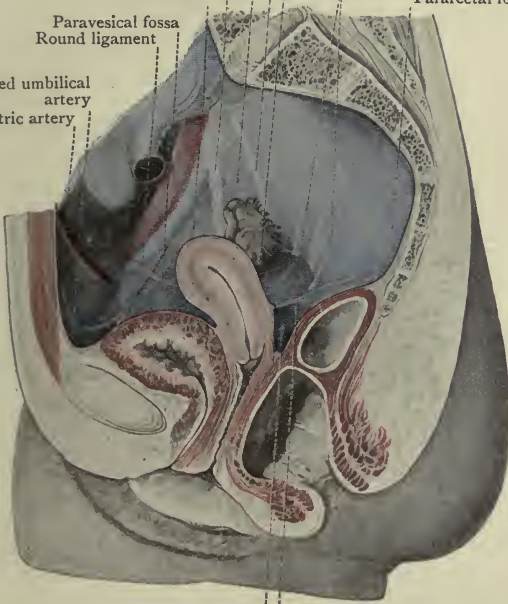


FIG. 223.—Median section through the Female Pelvis to show the disposition of the Peritoneum in relation to the Viscera and to the Side Wall of the Cavity. (Dixon and Birmingham.)

anterior surface contains the *round ligament of the uterus*. The portion of the broad ligament between the uterine tube and the ovary is termed the *mesosalpinx*. The fold which proceeds from the posterior surface of the ligament to the ovary is the *mesovarium*, and the portion of the broad ligament below the level of the mesovarium is sometimes called the *mesometrium*. In addition to the uterine tube, the ovary and its ligament, and the round ligament of the uterus, the two layers of the broad ligament include between them other structures, viz., (1) the *epoophoron*; (2) the *uterine* and *ovarian blood-vessels* and *nerves* and lymph vessels.

Peritoneal Fossæ.—The paravesical fossæ lie in front of the broad ligament, at the sides of the urinary bladder.

Each middle or genital fossa is bounded *anteriorly* by the back of the broad ligament and a ridge, called the ureteral ridge because it is caused by the projection of the ureter, and *posteriorly* by a fold of peritoneum, called the *utero-sacral fold*, which is similar to the sacro-genital fold of the male (p. 412). Each utero-sacral fold is semilunar in form, and curves from the back of the uterus to the posterior wall of the pelvis, at the side of the rectum. Between its two layers there are some unstriped muscular fibres as well as connective tissue. The two folds meet across the back of the uterus, where they form a projection known as the *torus uterinus*.

The pararectal fossæ are situated at the sides of the empty rectum, between it and the utero-sacral fold.

Excavatio Recto-uterina (O.T. **Pouch of Douglas**).—The recto-uterine pouch corresponds to the recto-genital pouch or recto-vesical excavation in the male. *Anteriorly*, it is bounded by the peritoneum covering the upper part of the posterior wall of the vagina and the lower part of the back of the uterus; *posteriorly*, by the peritoneum on the rectum; while *on each side* is the utero-sacral fold of peritoneum. It is continuous with the pararectal fossæ, which are obliterated when the rectum is distended (p. 413).

Excavatio Vesico-uterina.—The vesico-uterine pouch is a shallow depression, not always distinguishable, between the uterus and the upper part of the base of the urinary bladder. It is bounded laterally by two slight folds of peritoneum termed the *utero-vesical folds*.

Dissection.—The dissector should cut through the lateral false ligaments of the urinary bladder at their junctions with the lower borders of the anterior surfaces of the broad ligaments: he should then reflect the lateral false ligaments medially to the lateral borders of the upper surface of the urinary bladder. Next, he should draw the apex of the bladder backwards and pass his index finger down through the soft fat, between the anterior border of the bladder and the back of the symphysis pubis, till he feels the resistance of the upper fascia of the pelvic diaphragm, which passes medially from the wall of the pelvis to the bladder, and which is thickened on each side of the median plane to form the *medial pubo-vesical ligaments*. Those ligaments having been recognised, the finger should be carried laterally and then backwards between the wall of the pelvis and the urinary bladder as far as the lateral border of the broad ligament. The dissector will find he can do this quite easily, and by doing it he will demonstrate the fact that between the anterior border and infero-lateral surfaces of the bladder and the wall of the pelvis there is a space filled with easily displaced extra-peritoneal fat ; it is the lower and anterior part of the so-called *cave of Retzius*, and it is bounded below by a layer of fascia called the visceral pelvic fascia which extends from the side wall of the pelvis to the pelvic viscera. The finger should now be passed still farther backwards along the side wall of the pelvis, beyond the lateral border of the broad ligament, until the front of the hypogastric artery is reached ; but little resistance will be met, and the dissector will be able to satisfy himself that the lower part of the so-called cave extends round the sides and front of the pelvis from the hypogastric artery of one side to the corresponding vessel of the opposite side. The upper part of the cave lies behind the anterior abdominal wall, extending upwards between the inferior epigastric arteries to the level of the umbilicus. The cave is of practical importance, because, on account of the laxity of its fatty contents, urine escaping from a ruptured urinary bladder, or effused blood, or inflammatory exudations, can spread rapidly throughout the area ; moreover, it is an area in which the surgeon can readily separate the pelvic contents from the pelvic wall. Having satisfied himself as to the presence and the boundaries of the cave, the dissector should carefully remove the extra-peritoneal fat which lies between the urinary bladder and the wall of the pelvis minor, taking care to avoid injuring any vessels which may be passing through the fat. When he has completed this part of the dissection he will have displayed on the side wall of the pelvis the following structures :—The obliterated umbilical artery, lying a short distance below the level of the pelvic brim ; the obturator nerve, below the ligament ; and, at a still lower level, the obturator artery and vein. Passing from the umbilical artery to the bladder, the superior vesical artery will be found. Lateral to the obturator vessels and nerve, the parietal pelvic fascia will be seen ; and at the bottom of the space he will find the visceral layer of the pelvic fascia passing medially from the parietal layer to the bladder. Just to the lateral side of the junction of the lateral border with the posterior border of the urinary bladder he will find the lower end of the ureter, and, if he passes a finger into the vagina, he will recognise that the lower end of the ureter is crossing a recess of the vagina, at the side of the lower end of the uterus, which is called the *lateral fornix* of the vagina (Fig. 228). If the lower border of the broad ligament is now carefully raised, the uterine artery will be found passing medially above the ureter to the side of the uterus (Fig. 227).

Having displayed the structures in front of the broad ligament, the dissector should turn to the posterior part of the pelvis, where he must carefully divide the peritoneum along the back of the lower border of the broad ligament, and then turn the membrane behind the incision medially from the side wall of the pelvis minor to the rectum. When that has been done and the extra-peritoneal fat has been dissected away, the ureter, the divisions and branches of the hypogastric artery, the accompanying veins, and the pelvic plexuses of the sympathetic nerves passing forwards at the sides of the rectum, will be exposed. Whilst this stage of the dissection is proceeding care must be taken to avoid injuring the parietal or the visceral pelvic fascia. The hypogastric vessels lie inside the fascia, and their visceral branches pierce the visceral layer, whilst the parietal branches pierce the parietal layer. The main nerve trunks and the trunks of the sympathetic are outside the parietal fascia ; therefore their branches do not pierce the fascia as they pass out of the pelvis. The obturator nerve, however, pierces the parietal pelvic fascia, from without inwards, at the posterior part of the pelvis, and runs forwards, lateral to the hypogastric vessels and below the pelvic brim, to the upper part of the obturator foramen, where it enters the obturator canal, through which it passes into the thigh.

When the extra-peritoneal fat has been removed, the general positions of the structures behind the broad ligament should be noted (Figs. 224, 225). The hypogastric artery serves as a prominent landmark as it descends at the junction of the side wall with the posterior wall of the pelvis. In front of the hypogastric artery the ureter runs downwards till it reaches the level of the visceral layer of the pelvic fascia ; then it turns forwards and medially to the corresponding posterior angle of the bladder. As it runs forwards and medially it passes beneath the lower border of the broad ligament and the uterine artery, and obliquely above and in front of the upper end of the vagina.

The student should verify the important relations of the ureter to the vagina and to the uterus by passing a finger into the vagina, and noting that when the tip of his finger lies at the top of the vagina and at the side of the lower end of the uterus, it is immediately below the medial part of the lower border of the broad ligament, and that the ureter passes obliquely, from behind forwards and medially, across it.

Running forwards on the side wall of the pelvis, and passing to the lateral side of the ureter, will be found the obliterated umbilical artery and the obturator nerve and vessels. In the female, the obliterated umbilical artery is frequently below the level of the obturator nerve behind the broad ligament, but it rises above the nerve as it passes forwards. The uterine artery will be found descending in front of the ureter, before it turns medially to cross above the duct, beneath the lower border of the broad ligament.

The hypogastric vein lies behind the stem of the hypogastric artery, and frequently conceals its posterior division.

Endo-Pelvic Fascia.—The fascia of the pelvis minor should now be examined. It is a strong membranous layer

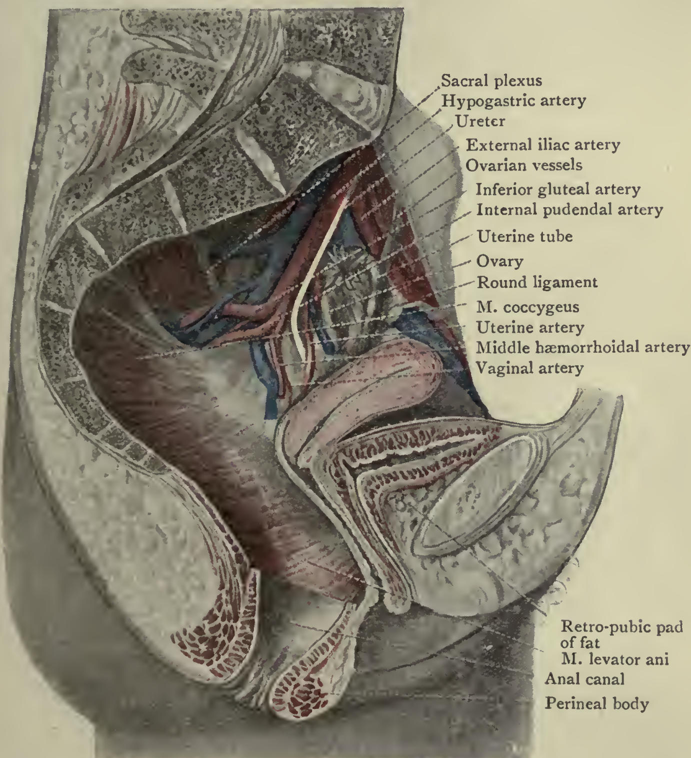


FIG. 224.—Dissection of a median section of a Female Pelvis, showing the Pelvic Diaphragm and the structures on the side wall of the Pelvis behind the Broad Ligament.

which is separable into two parts—a *parietal portion* which forms one of the strata of the walls of the pelvis; and a *visceral portion*, consisting of the upper fascia of the pelvic diaphragm, which forms part of the pelvic floor, and lies upon the muscular diaphragm which separates the pelvis proper from the perineum. The parietal layer passes down below the level of the visceral layer into the perineum, where it is still spoken of as parietal pelvic fascia. The dissector should commence his examination of the fascia by noting that the parietal part is continuous above with the fascia on the psoas major muscle. Traced downwards from the psoas, it can be followed to the level of a line extending from the lower part of the back of the symphysis to the spine of the ischium, *i.e.*, to the level at which the visceral layer springs from its inner surface. Traced backwards, it passes lateral to the hypogastric vessels and then across the front of the sacrum to the opposite side, concealing the sacral plexuses and the piriformes muscles.

When it is traced forwards it will be found to terminate, anteriorly, along a curved line which commences at the medial side of the ilio-pectineal eminence, on the inner surface of the superior ramus of the pubis, descends to the lower border of the symphysis pubis, and then ascends to a corresponding point on the opposite side. The parietal fascia is deficient, therefore, on the anterior boundary of the lower part of the cave of Retzius. Each half of this anterior border of the parietal fascia is separable into three parts: A lateral part, where the fascia blends with the periosteum on the pelvic surface of the superior ramus of the pubis; an intermediate part, below the highest portion of the obturator foramen, where the fascia turns over the upper border of the obturator internus and runs outwards into the thigh, forming the lower wall of the obturator canal; a medial part, which is attached to the periosteum on the pelvic surface of the body of the pubis.

Turning next to the visceral layer, the dissector will find as he traces it medially, in the posterior part of the pelvis, that the rectum sinks into its substance. In front of the rectum it is carried over the upper part of the vagina on to the uterus, and in front of the uterus it is lost on the urinary bladder. Still more anteriorly, it can be followed across the median plane to the opposite side. In this last part of its extent two thickened bands of its substance, one on each side of the median plane, extend from the back of the pubis to the anterior border of the bladder. Those bands are the medial pubo-vesical ligaments or anterior true ligaments of the bladder, already referred to. The dissector should note that the attachment of the visceral layer to the back of the body of the pubis lies at a higher level than the attachment of the anterior border of the parietal layer. In the space between the two lines of attachment, on each side, the anterior fibres of the corresponding levator ani arise from the back of the body of the pubis.

The dissector should now turn to the perineum and examine the pelvic fascia from below. He has already seen that it forms the lateral wall of the ischio-rectal fossa and is carried medially from the margin of the pubic arch, as the superior fascia of the urogenital diaphragm, to the median plane, where it turns backwards along the urethra and round the anterior border of the levator ani.

He has seen also that the levator ani arises from the parietal fascia of the lateral wall of the ischio-rectal fossa and passes downwards and medially to the wall of the anal canal, into which many of its fibres are inserted. The levator ani must now be divided from before backwards, midway between its origin and its insertion, and the upper portion must be turned towards the pelvic wall. When that has been done, the lower surface of the superior fascia of the pelvic diaphragm will be exposed, and the dissector will see, after the removal of the peritoneum and extra-peritoneal fat above, and the levator ani below, that now the visceral fascia alone separates the pelvic cavity above from the perineum below, and he can convince himself that the visceral layer springs from the parietal layer immediately above the origin of the levator ani, and that, as it runs towards the median plane, it encloses the pelvic viscera. He will find also, if he traces the inferior surface of the visceral layer forwards, that it blends anteriorly, round the anterior border of the levator ani, with the upper fascia of the urogenital diaphragm, which is formed by the parietal layer of the pelvic fascia. He has still to demonstrate the cleavage of the visceral layer into secondary lamellæ which ensheathe the pelvic viscera. To do this he must take the following steps :—

Dissection.—Detach the crura of the clitoris from the margins of the pubic arch and trace the dorsal vein of the clitoris beneath the arcuate ligament. Divide the dorsal vein and turn the clitoris down. Separate the inferior fascia of the urogenital diaphragm from the margin of the pubic arch on each side, if that has not already been done during the dissection of the perineum. Examine the sphincter urethræ membranaceæ, which lies above the inferior fascia of the urogenital diaphragm. Divide the sphincter urethræ membranaceæ on each side and turn it towards the median plane. Pass a probe into the urethra and note that the anterior fibres of the sphincter pass in front of the urethra, and that its posterior fibres pass over the wall of the vagina. Above the sphincter urethræ membranaceæ lies the upper fascia of the urogenital diaphragm, which is now seen from the front. Pass a finger into the vagina, and note that both the urethra and the vagina pass through the upper fascia of the urogenital diaphragm, which is reflected upwards along their borders.

Divide the upper fascia of the urogenital diaphragm on both sides, and again note that, at the sides of the urethra and the vagina, it is continuous round the anterior border of the levator ani with the visceral layer of the pelvic fascia.

Divide the pubes on each side, with the saw, along a line commencing on the margin of the pubic arch, below the attachment of the arcuate ligament, and terminating above at the lateral border of the tubercle of the pubis. Pass the knife behind the pubis and separate the visceral layer of the pelvic fascia from its attachment to the bone between the saw cuts. The separated piece of bone may now be removed and should be kept for the examination of the ligaments of the symphysis (see pp. 474, 475). If necessary, a further portion of the margin of the pubic arch may be removed, on each side, to give room for the examination of the relations of the vagina and the urethra.

The dissector should now make his final examination of the pelvic fascia. Tracing the upper surface of the visceral layer medially, he will find that it spreads out on the infero-lateral surfaces and anterior border of the urinary bladder, and that, below the bladder, it covers the front of the urethra and the vagina. The latter part presents a free border where it was detached from the back of the pubes, and beneath that border the dorsal vein of the clitoris can be traced towards the bladder, where it joins the vesical plexus. In that part of the fascia the two thickened bands which form the medial pubo-vesical ligaments will be noted. If the dissector next traces the fascia medially, *following its lower surface*, he will find that it passes behind the rectum, and he will thus demonstrate that the visceral layer of the pelvic fascia splits as it passes towards the median plane, one layer, *the vesical*, passing on to the bladder and in front of the urethra and vagina, and a second layer, *the rectal*, which passes behind the rectum. There is, however, a third layer, *the recto-vaginal*, which crosses between the rectum and the vagina. To demonstrate that layer the dissector should divide the vesical layer in the median plane in front of the bladder, and turn the lateral halves towards the side walls of the pelvis. In that way he will expose the urethra and the anterior wall of the vagina, the two being closely bound together, and when the lateral border of the vagina is reached he will find that the vesical layer of the fascia blends with a deeper layer which passes behind the vagina; that layer is the recto-vaginal layer. On the anterior wall of the vagina, and, more particularly, along its lateral border, the dissector should note a plexus of veins, the *vaginal plexus*.

The recto-vaginal layer of the pelvic fascia should be displayed from below also. To do that the dissector must cut transversely through the tissue of the perineal body, which lies in front of the anal orifice, until he reaches the junction of the anal passage with the rectum. When that point is attained he will find that he can quite easily separate the rectum from the vagina with his finger, and that intervening between the two is the recto-vaginal layer of fascia which he previously exposed from above.

Before terminating his study of the visceral layer of the

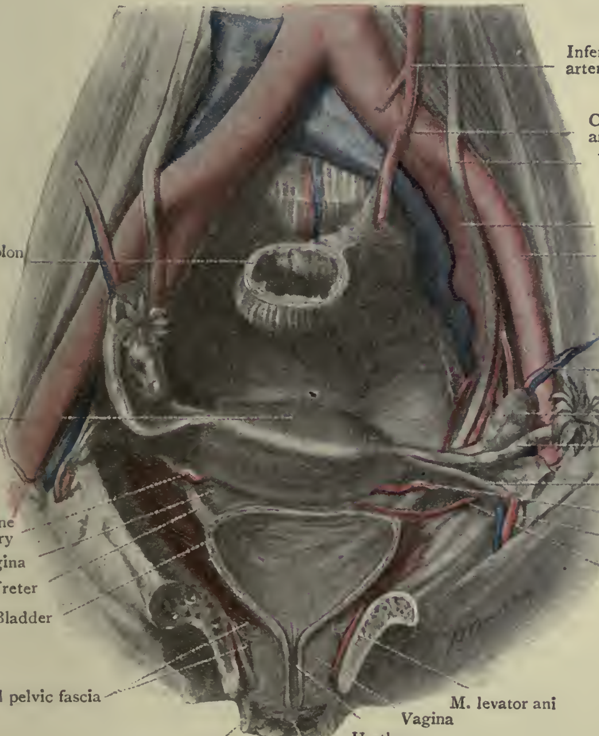


FIG. 225.—Dissection of the Pelvis of a multiparous female, showing the relations of the Bladder to the Uterus and Vagina, the relations of the Vagina to the Urethra and Broad Ligaments, and the relations of the Ureters to the Broad Ligaments and Vagina.

pelvic fascia the student should note that the floor of the pelvic cavity of the female is formed, as in the male, by the levatores ani and the coccygei muscles, and the upper and lower fascial layers of the urogenital diaphragm, but it is pierced by three canals instead of two, viz., the urethra and the anal passage, as in the male, and, between them, the vagina. In that way the floor of the pelvis, in the female, is rendered relatively weak and less capable of resisting strain, whilst at the same time it is adapted to the function of child-bearing, for it is cleft by the vaginal canal into two segments—an anterior, including the anterior vaginal wall and all the parts in front of it, and a posterior, formed by the posterior vaginal wall and the parts behind it. The former can be lifted into the pelvis and the latter can be forced downwards, much as the two segments of a folding door are displaced in opposite directions, and thus a passage is made for the exit of the child (Berry Hart). The dissector should note also, as a matter of clinical importance, that, whilst the urethra and the anterior wall of the vagina are closely bound together and cannot be separated, except by the use of the knife, the posterior wall of the vagina and the anterior wall of the rectum are only loosely united together, and can easily be torn apart.

Vesica Urinaria.—The urinary bladder, in the female, has normally a smaller capacity, and it lies at a somewhat lower level in the pelvis than the male bladder; but its shape when empty and slightly contracted is the same as in the male, *i.e.*, it has the form of a three-sided pyramid, possessing a *superior surface*, two *infero-lateral surfaces*, a *fundus* or *base*, and an *apex*. The superior surface is covered with peritoneum. It is bounded by two lateral borders, which separate it from the infero-lateral surfaces, and by a posterior border, which separates it from the base. The two lateral borders converge anteriorly and meet at the *apex*, from which a fibrous cord, the middle umbilical ligament or urachus, passes up the posterior surface of the anterior abdominal wall to the umbilicus. The urachus is the remains of part of the cloaca of the fœtus. The lateral borders meet the posterior border of the upper surface at the *posterior angles* of the bladder, where the ureters enter the wall of the viscus. The infero-lateral surfaces, and the anterior border, which separates them, are devoid of peritoneum. They form the posterior wall of the lower part of the cave of Retzius, and are separated from the back of the symphysis and the pelvic surfaces of the pubic bones by a layer of loose, extra-peritoneal fat. The term *retro-pubic pad* is applied to that portion of the fatty tissue which intervenes between the back of the symphysis pubis, the upper surfaces of the medial pubo-vesical ligaments, and the anterior border of the bladder. To examine the relation of the fundus of the bladder to the uterus and vagina, the student must cut through the peritoneum at the bottom of the vesico-uterine pouch, and then separate the bladder from the front of the neck of the uterus and the upper part of the anterior wall of the vagina. Whilst he is dividing the peritoneum he should notice that the membrane may extend down over the fundus of the bladder for a very short distance.

The False Ligaments of the Urinary Bladder.—As in the male, there are five false ligaments of the bladder, two *lateral*, two *posterior*, and one *superior*. They are all formed by the peritoneum. The two *lateral* are merely the parts of the peritoneal membrane which connect the lateral borders of the superior surface of the bladder with the side walls of the pelvis; they form the floors of the paravesical fossæ. The *superior*, or middle umbilical fold, is the fold of peritoneum which is raised up by the middle umbilical ligament; and the two *posterior* are the ill-marked folds which pass from the upper part of the base of the bladder to the front of the neck of the uterus; they form the lateral boundaries of the vesico-uterine pouch. The dissector should compare the false ligaments of the urinary bladder of the female with the corresponding false ligaments in the male (see p. 413).

The True Ligaments of the Urinary Bladder.—The true ligaments of the urinary bladder are five in number, two *anterior*, two *lateral*, one *superior*. The lateral and the anterior ligaments are portions of the visceral layer of pelvic fascia. The lateral pubo-vesical ligaments are merely the lateral parts of the vesical lamella; whilst the anterior or medial pubo-vesical ligaments are thickenings of the anterior part of the same lamella, one on each side of the median plane. The lateral connect the infero-lateral surfaces of the bladder to the main layer of the visceral pelvic fascia, and indirectly to the side wall of the pelvis. The anterior bind the anterior border of the bladder to the back of the symphysis pubis. It is doubtful if the term superior true ligament is properly applied, but it is sometimes given to the middle umbilical ligament, which connects the apex of the bladder with the anteiror abdominal wall.

Dissection.—To examine the interior of the bladder, the dissector should make an incision through the anterior border,

and through the infero-lateral surfaces immediately below their junction with the superior surface. When that has been done the superior surface should be raised and the anterior border and infero-lateral surfaces should be depressed; a good view of the interior will then be obtained. The mucous membrane should be cleaned with a sponge and its general characters and the orifices of the bladder should be studied.

The Mucous Membrane, the Trigone, and the Orifices of the Urinary Bladder.—Over the greater part of the inner surface of the empty bladder the mucous membrane is rugose, on account of the laxity of its connection with the muscular coat; but in a triangular area on the lower part of the fundus, which is known as the *trigone*, the connection is closer and the mucous membrane is always smooth. The rugæ on the other parts of the inner surface become unfolded as the bladder distends, until the whole inner surface is smooth. The trigone is also the most sensitive area of the bladder wall. At its apex, which marks the lowest point of the base of the bladder, is situated the semilunar or Y-shaped *internal orifice of the urethra*; and at its lateral angles, which are about one inch from each other and the same distance from the orifice of the urethra, lie the slit-like orifices of the ureters. The student should pass probes into the ureters; he will then be able to convince himself that each ureter runs for about three-quarters of an inch in the substance of the bladder wall, and that that part of each duct can be easily palpated through the anterior wall of the vagina. The obliquity of the ureters in the substance of the bladder wall is believed to produce a valve-like action of the lower parts of the ducts, permitting the passage of urine into the bladder, but preventing its return.

Relations of the Bladder.—Each infero-lateral surface forms a part of the posterior wall of the cave of Retzius, and it is separated by extra-peritoneal fat from the back of the body of the pubic bone and from the fascia covering the pelvic surfaces of the corresponding obturator internus and levator ani muscle. The anterior border, which separates the infero-lateral surfaces, lies behind the symphysis and above the medial pubo-vesical ligaments. The neck of the bladder, which lies at the meeting of the infero-lateral surfaces and the lower angle of the fundus, is closely bound to the anterior surface of the vagina, whilst in the male it is embraced by the base of the prostate (see p. 443).

The superior surface, which is in relation, in the male, with coils of small intestine and pelvic colon, is overhung posteriorly by the uterus in the female, and is in relation with small intestine or a coil of the pelvic colon only in the anterior part of its extent. The fundus of the urinary bladder, which, in the male, is in relation with the deferent ducts and the seminal vesicles, is closely bound, in the female, to the anterior surface of the neck of the uterus and to the upper part of the anterior wall of the vagina (Fig. 220).

Peritoneal Relations.—The peritoneal relations of the urinary bladder are the same in the female as in the male (see p. 445). The alterations in the peritoneal relations which occur as the bladder distends are the same in both sexes (see p. 446).

Changes in the form of the Bladder.—The changes which occur in the form of the bladder as it passes from the empty to the distended condition are the same in the female as in the male (see p. 443).

Urethra Muliebris (Female Urethra).—The urethra is the canal by which the urine leaves the bladder. Its length is about 38 mm. (one and a half inches). It takes a slightly curved course from the neck of the bladder downwards and forwards to the vestibule, where it opens on the surface by an aperture called the *orificium urethræ externum.* The orifice usually presents the appearance of a vertical slit, and lies immediately in front of a prominent projection of the mucous membrane at the lower extremity of the anterior vaginal wall. The projection is easily felt, and when the finger is passed over the vestibular area the position of the external orifice is readily localised. On its way to the surface the urethra passes through the two fasciæ of the urogenital diaphragm, and in the interval between them it is surrounded by the fibres of the sphincter urethræ membranaceæ muscle. In the whole of its length it is closely bound to the anterior wall of the vagina, and its walls are in close apposition, except when the passage is opened by the flow of urine through it.

The urethra should be split open longitudinally so that its coats can be examined. They are—(1) a muscular coat; (2) a submucous coat; (3) a mucous coat. The muscular coat consists of an outer layer of circular and an inner layer of longitudinal fibres. The circular fibres are strongly developed in the region of the neck of the bladder, where they form a distinct sphincter. The submucous coat connects the mucous coat loosely with the muscular coat. The mucous coat is thrown into longitudinal folds. It contains a number of gland follicles and lacunæ, and, in addition, there are present in its ventral wall two longitudinal tubules, called the *para-urethral ducts.* They open either into the urethra close to its external orifice, or directly into the vestibule close to the orifice.

The Ureters.—The portions of the ureters, which lie in the pelvis minor in the female, are slightly longer than the corresponding parts in the male, owing to the greater width of the pelvis and to the greater depth at which the bladder lies.

In the female, as in the male, the pelvic portion of each ureter first descends, along the side wall of the pelvis immediately in front of the hypogastric artery, and then turns forwards and medially, towards the bladder, resting upon the upper surface of the levator ani. As it descends its relations are in the main similar to those of the corresponding part of the ureter in the male. Immediately behind it is the hypogastric artery. Lateral to it, from above downwards, lie the medial margin of the psoas major muscle, the umbilical artery,[1] the obturator nerve, and the obturator vessels. Its anterior and medial borders are covered with peritoneum. The anterior border is in relation with the corresponding ovary. It forms the posterior boundary of a shallow depression, on the side wall of the pelvis minor, in which the ovary is lodged and which is called, therefore, the ovarian fossa. The medial, peritoneal covered border of the right ureter is in relation with coils of small intestine, and the corresponding border of the left ureter is in relation with the pelvic colon.

The relations of the lower part of the pelvic portion of the ureter, which runs medially, are very different in the two sexes. In the female that portion of the ureter runs forwards and medially and passes obliquely beneath the lower border of the broad ligament and obliquely across the side and front of the upper end of the vagina (Fig. 225), and it enters the corresponding posterior angle of the bladder about 50 mm. (two inches) from its fellow of the opposite side. Beneath the broad ligament, and at the lateral border of the upper end of

[1] The relative positions of the umbilical artery and the obturator nerve may be reversed.

the vagina, the uterine artery crosses above it, and, just before it enters the bladder, it lies immediately in front of the upper part of the anterior vaginal wall (Fig. 225). When the bladder is distended and the vagina is narrow the posterior angles of the bladder may extend beyond the lateral borders of the vagina; in such cases the relations of the ureters to the

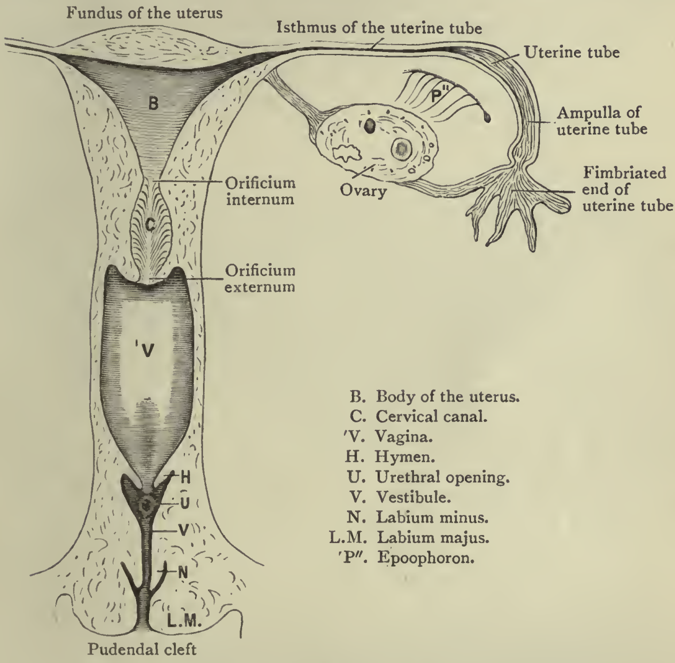


FIG. 226.—Diagram of the Vulva, Vagina, and the Uterus, with its Appendages. (Symington.)

vagina are much less intimate. For the relations of the corresponding part of the male ureter see p. 447.

Uterus. — The uterus is the organ in which the impregnated ovum is retained until the fœtus is fully developed. It lies in the middle part of the pelvis, resting upon the posterior part of the upper surface of the bladder, and lying beneath coils of small intestine. It is of modified piriform shape, being flattened from before backwards. In length it measures about 75 mm. (three inches), and its long axis lies in the axis of the upper aperture of the pelvis minor, and almost at right angles with the long axis of the vagina (Fig. 224). Its *breadth*, at the broadest part, is about 50 mm. (two inches), and its greatest *thickness* is 25 mm. (one inch). Its broad, upper end is directed upwards and forwards, and is continuous at each side with a uterine tube. Its narrower, lower end, which is directed downwards and backwards, passes through the upper part of the anterior vaginal wall into the cavity of the vagina.

It is customary to describe the uterus as consisting of three parts, viz., a fundus, a body, and a cervix.

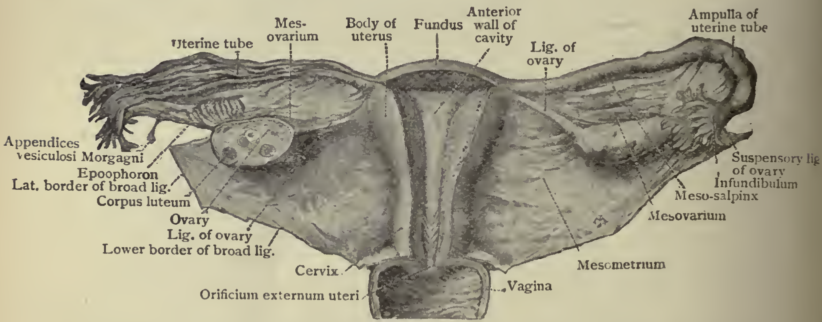


FIG. 227.—The Uterus, the Uterine Tubes, the Ovaries, the Broad Ligaments, and the upper part of the Vagina, seen from behind. The posterior wall of the uterine cavity has been removed, and the left Uterine Tube and the upper part of the Vagina have been opened.

Fundus Uteri.—The fundus is that portion of the rounded upper end which lies above a line drawn transversely across the organ between the points where the uterine tubes enter. It is completely covered with peritoneum.

Corpus Uteri.—The body of the uterus diminishes in breadth as it proceeds downwards to the neck. In front and behind, it is convex, the convexity of the posterior surface, however, being much more marked, especially in its upper part, than that of the anterior surface. Each border is connected to the corresponding broad ligament, and immediately below the entrance of the uterine tube it is joined, in front, by the *round ligament*, and, behind, by the *ligament of the ovary*. Inferiorly, the body of the uterus is marked off from the cervix by a slight constriction, which, although very apparent in the infant, becomes less distinct as puberty approaches, and usually disappears altogether after parturition. This constriction is called the *isthmus.*

Cervix Uteri.—The cervix, or neck, of the uterus is about 25 mm. (one inch) in length; it is narrower than the body and more cylindrical in form. It projects into the upper end of the vagina, the walls of which are attached around it.

To obtain a satisfactory view of the relation of the uterus to the vagina, both organs should now be split sagittally, care being taken to avoid injuring the rectum. When the section has been made, the posterior wall of the vagina will be found to ascend to a higher level on the cervix than the shorter anterior wall (Figs. 224, 229). On the lower extremity of the cervix, which rests against the posterior vaginal wall, there is an orifice, the *orificium externum uteri* (O.T. *os uteri externum*). The orifice, in nulliparæ, is always a small transverse slit, with rounded anterior and posterior lips, but in women who have borne children it is usually larger, and its margins are more irregular in outline. The anterior lip is the shorter, and it is placed at a lower level in the vagina. The difference in the level and in the length of the two lips is due to the fact that the uterus passes obliquely through the vaginal wall. The part of the cervix which projects into the vagina is the *vaginal portion*; the part above is termed the *supravaginal portion.*

Cavum Uteri.—The cavity of the uterus is separable into two parts, the cavity of the body and the cavity of the cervix. The cavity of the body is a mere cleft, triangular in outline, which lies between the anterior and posterior walls. The base of the triangle is above, and at each of its angles a uterine tube opens into the cavity. The apex is below, where the cavity of the body joins the cavity of the cervix, at a constricted aperture of communication called the *orificium internum uteri* (O.T. *os uteri internum*).

The cervical portion of the cavity is spindle-shaped and slightly compressed from before backwards. It extends from the internal orifice, where it is continuous with the cavity of the body, to the external orifice, where it opens into the vagina.

The Relations of the Uterus.—The posterior surface of the uterus is completely covered with peritoneum, and it is separated from the rectum by the recto-vaginal pouch, in which lie coils of the small intestine and part of the pelvic colon. The anterior surface of the body, which rests on the bladder, is also covered with peritoneum, but the anterior surface of the cervix is devoid of peritoneum, and is in direct relation with

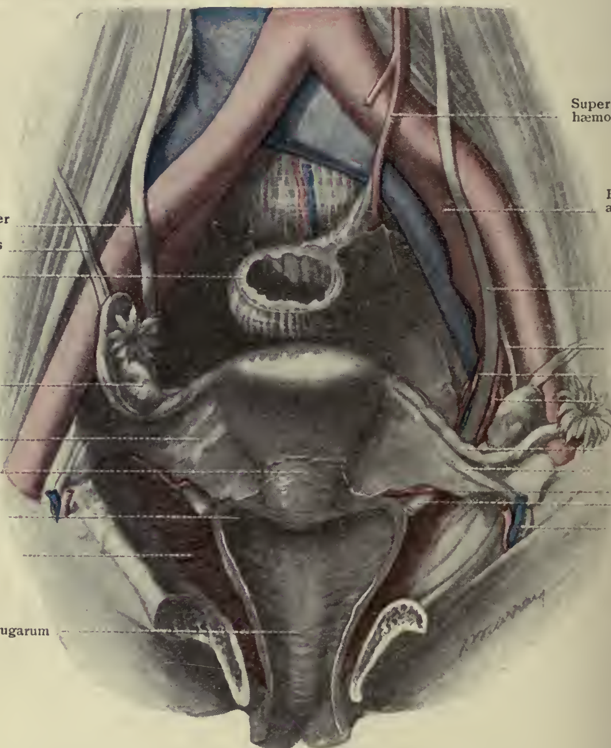


FIG. 228.—Further Dissection of the Pelvis shown in Fig. 225. The Uterus has been pushed backwards, and the Bladder, the lower parts of the Ureters, and the anterior wall of the Vagina have been removed.

the fundus of the bladder. The lateral borders of the uterus are connected with the broad ligaments, and between the layers of the ligaments each is associated with the corresponding uterine artery, and uterine plexus of veins, which are embedded in a mass of loose fatty tissue called the *parametrium*. The parametric tissue is most abundant in the region of the upper part of the vagina and at the side of the neck of the uterus.

Ligamenta Teretia Uteri (Round Ligaments).—The round ligaments of the uterus are two cord-like bands, one on each side, composed of involuntary muscle fibres and connective tissue. They are attached to the body of the uterus, immediately below and in front of the entrance of the uterine tubes. Each ligament runs forwards and laterally from the uterus, in a fold of the anterior layer of the corresponding broad ligament, to the side wall of the pelvis. There it lies for a short distance on the external iliac vessels, and then turns round the inferior epigastric artery, and passes through the abdominal inguinal ring into the inguinal canal, where it has already been examined. It represents the lower part of the gubernaculum of the ovary, the upper part being represented by the ligament of the ovary.

Position of the Uterus.—In women who have borne no children (nulliparæ), and in whom the bladder and the rectum are both empty, the uterus is normally *anteflexed* and *anteverted.* The statement that the uterus is anteflexed means that it is bent forwards on itself at the isthmus, so that the body and the cervix meet at an angle which is open in front. This forward flexion depends upon two circumstances, viz.—(1) upon the greater pliability of the body as compared with the firmer consistence and greater resistance of the cervix; and (2) upon the fact that the cervix is more or less held in position by its attachments to the anterior vaginal wall and the fundus of the bladder in front, and to the posterior vaginal wall behind. The term anteversion means that the whole uterus—body and cervix—is inclined forwards and forms an angle of greater or less magnitude with the vertical axis of the trunk. When the uterus is in its usual position, coils of small intestine and a loop of the pelvic colon rest upon its posterior surface, and its anterior surface is supported by the bladder. It is only on rare occasions that a coil of small intestine is found between the uterus and the bladder, in the vesico-uterine pouch of peritoneum. In multiparæ (women who have borne children) the anteflexion is not so marked as in nulliparæ.

The uterus possesses a great degree of mobility, however, and its position is constantly liable to change, but under no circumstances does it occupy an exactly median position.

As a rule, its anterior surface is directed forwards and to the right. The ordinary anteflexion and anteversion may be diminished or exaggerated by alterations of the general intra-abdominal pressure, and by distension of the bladder and the rectum. They may be altered also by pathological contractions of the peritoneal ligaments connected with the uterus, or of the connective tissue between the folds of the ligaments. Every contraction of the diaphragm, every movement of the body, is accompanied or followed by some slight change in

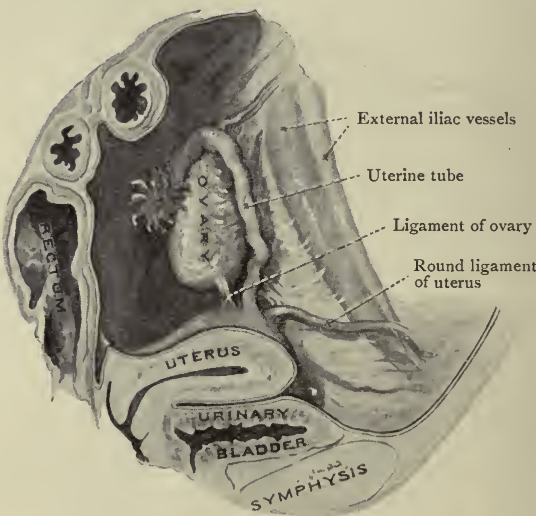


FIG. 229.—Left Side Wall of Female Pelvis to show position of the Ovary. The ovary is much scarred owing to the shedding of ova.

the position of the uterus. When the bladder fills, the uterus is raised, the anteflexion and anteversion become less marked, and, in cases of over-distension of the bladder, the uterus may assume an erect position, or may be even forced backwards until it lies in the same line as the vagina. When the uterus attains the last-mentioned position it is said to be *retroverted.* As it becomes retroverted the coils of intestine are displaced from the recto-vaginal pouch, and the uterus is forced into intimate relation with the rectum. When the rectum becomes distended the uterus is pushed forwards and usually to the right side.

Dissection.—**When the examination of the relations of the uterus is concluded, the dissector should cut through the rectum in the median plane. Then, with the saw, he should divide the sacrum and coccyx to the left of the middle sacral vessels, and when that has been done he should cut through all the remaining tissues in the same plane and separate the two halves of the pelvis. All the remaining stages of the dissection and examination can be carried out on each half separately.**

Vagina.—The vagina is the passage which leads from the uterus to the vulva. It is about 75 mm. (three inches) long, and it is widest at its upper end. Its distensibility is very great, to allow the passage of the child during parturition. The direction of the canal, when the bladder and rectum are empty, is from above downwards and forwards, parallel with the plane of the superior aperture of the pelvis minor, so that it forms with the uterus an angle which is open towards the symphysis. Its anterior and posterior walls are closely applied, and in section, therefore, its cavity appears either as a transverse or as a longitudinal slit, according to the direction in which it is divided (Figs. 221 and 224).

At its upper end the vagina is attached round the neck of the uterus, upon which it ascends farther posteriorly than anteriorly, so that the uterus appears to pierce the anterior wall of the vagina. The shallow sulcus at the upper end of the cavity of the vagina, around the neck of the uterus, is known as the *fornix* of the vagina. It is formed by the reflection of the mucous membrane of the vagina on to the neck of the uterus, and is separable into anterior, posterior, and lateral parts. The dissector should examine carefully the relations of the fornices. The *anterior fornix* is in relation with the base of the bladder. The *posterior fornix* is in relation with the recto-vaginal pouch of peritoneum, and therefore an injury of the vagina in that region may open into the lower part of the peritoneal cavity. Each *lateral fornix* lies below the lower medial angle of the broad ligament, and is in close relation with the ureter, the uterine artery, and the mass of fatty, vascular tissue, previously mentioned as the parametrium.

The opening of the lower end of the vagina into the urogenital cleft is partly closed, in the virgin, by the *hymen*. The hymen is formed by two antero-posteriorly placed crescentic folds of mucous membrane which are united in front and behind. After the hymen has been ruptured, its torn fragments, called *carunculæ hymenales*, persist round the opening.

The Relations of the Vagina.—The posterior wall of the vagina is in relation, above, with the recto-vaginal pouch of peritoneum. Below that pouch, it is in apposition with the anterior wall of the rectum (Fig. 224). The anterior wall of the vagina is related to the lower part of the base of the bladder and to the urethra. The lower end of the vagina is

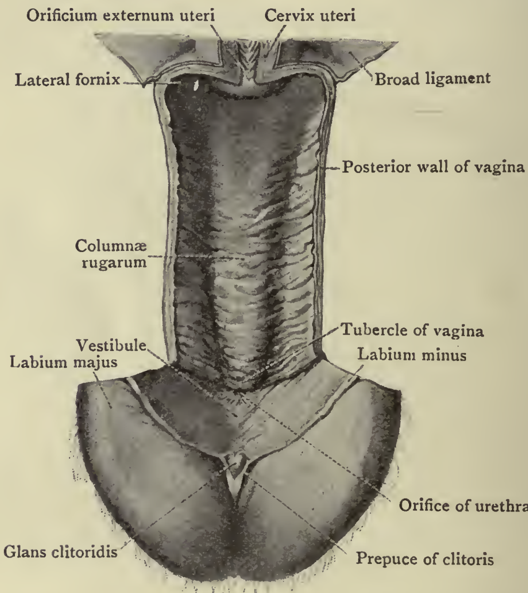


FIG. 230.—The lower part of the Cervix Uteri, the anterior wall of the Vagina, and the Vestibule. The Vagina has been opened from behind.

embraced between the vestibular bulbs, and is clasped by the bulbo-cavernosus, which acts as a sphincter, and each lateral border is supported by the corresponding levator ani muscle. The anterior borders of the levatores ani muscles, as they pass backwards from the pubic bones to the central point of the perineum, closely embrace the vagina, and act as a superior or second sphincter of the canal (Figs. 225, 228).

Tubæ Uterinæ (O.T. **Fallopian Tubes**).—There are two uterine tubes, one on each side, and their function is to convey ova from the ovaries to the uterus. Each uterine tube is about 10 cm. (four inches) long, and it is contained, in the greater part of its length, in the medial four-fifths of the upper border of the broad ligament. Its medial end pierces the uterus at the junction of the body and fundus. At a short distance from its lateral end it pierces the posterior surface of the broad ligament, curls over the upper pole of the ovary, and opens into the peritoneal cavity by a constricted orifice, the *ostium abdominale*, which is surrounded by a number of fringe-like processes called the *fimbriæ*. By one of the fimbriæ, the *fimbria ovarica*, it is attached to the tubal or upper pole of the ovary. Its calibre is by no means uniform. As it is traced from the uterus it is at first very narrow, scarcely admitting a bristle. That portion is called the *isthmus tubæ uterinæ*. More laterally the tube dilates considerably, and becomes convoluted and less closely attached to the peritoneum of the broad ligament. The dilated part is called the *ampulla tubæ uterinæ*. The ampullary portion of the tube terminates at the *ostium abdominale* which opens into the cavity of the *infundibulum tubæ*. The walls of the infundibulum are cleft into a number of processes called the *fimbriæ*, therefore the cavity of the infundibulum is very freely continuous with the cavity of the abdomen. The longest of the fimbriæ is attached to the ovary and, as already stated, it is called the *ovarian fimbria*. It is attached along its whole length to the broad ligament. On its surface is a gutter-like groove leading from the constricted mouth of the tube to the ovary. Traced from the uterus, the tube runs first laterally, then, at the side wall of the pelvis, it turns upwards, and finally, having gained the upper pole of the ovary, it bends downwards and covers the posterior free border and the greater part of the medial surface of the ovary (Fig. 229).

Ovaria.—The ovaries are two small, solid bodies, each of which is attached to the posterior surface of the corresponding broad ligament, by a secondary fold of the posterior layer of the ligament called the *mesovarium*. Each ovary has the form of a slightly compressed ovoid, and is about the size of a pigeon's egg. It presents two flattened surfaces, two extremities or poles, and two borders.

Its natural or typical position can be studied only in women who have borne no children, for the ovaries become displaced during pregnancy, and it is doubtful if they ever regain their original positions. In the nulliparous female each ovary occupies a peritoneal fossa on the back part of the side wall of the pelvis, below the external iliac vessels and in front of the hypogastric vessels and the ureter. The recess is termed the *fossa ovarica.* The long axis of the ovary is vertical. From its *upper pole* the suspensory ligament of the ovary passes to the side wall of the pelvis, and to the same extremity the mouth of the uterine tube is attached by the ovarian fimbria of the infundibulum of the uterine tube; on account of the latter connection the upper pole is frequently called the *tubal extremity* of the ovary. The lower or *uterine extremity* is connected with the lateral border of the uterus, immediately below and posterior to the entrance of the uterine tube, by the round cord-like *ligament of the ovary*, which lies in the medial part of the mesovarium, and is a remnant of the gubernaculum of the ovary. The *anterior border* is commonly called the *attached border* or *hilum*, because it is connected to the back of the broad ligament by the mesovarium, and because, through it, the vessels and nerves pass into and out of the ovary. The *posterior border* of the ovary is free, and looks backwards towards the ureter. The medial surface of the right ovary is in relation with a coil of the small intestine, and the medial surface of the left ovary is in relation with the pelvic colon. The lateral surface of each ovary, in the nulliparous female, lies against the side wall of the pelvis minor.

In the natural position of the organs the uterine tube encircles the greater part of the circumference of the ovary.

On each surface of the ovary, close to the anterior border, a white line marks the transition of the flat endothelial cells of the peritoneum into the cubical epithelium of the surface of the ovary. Before puberty the surface of the ovary is smooth; after that period it becomes scarred and puckered by the cicatrices which mark the positions of the ruptured Graafian or vesicular ovarian follicles from which ova have escaped.

Epoophoron (O.T. Parovarium).—The epoophoron is a structure of interest because it represents the lobules of the epididymis and part of the duct of the epididymis of the male. The dissector will find it by stretching the broad ligament, holding it to the light, and examining the lateral part, between the ovary and the uterine tube. It lies between the layers of the broad ligament, and consists of a horizontal tubule and a series of vertical tubules. The vertical tubules radiate from the region of the hilum of the ovary to the horizontal tubule, in which they terminate. The horizontal tubule lies about midway between the ovary and the uterine tube, and runs parallel with the latter. Traced towards the uterus, it is found to end blindly. Laterally, it may end in a similar manner, or it may pierce the posterior layer of the broad ligament and end in a dilated vesicle, of piriform shape, called the *vesicular appendix* or *hydatid of Morgagni*. The vesicular appendix may be attached to one of the fimbriæ of the uterine tube.

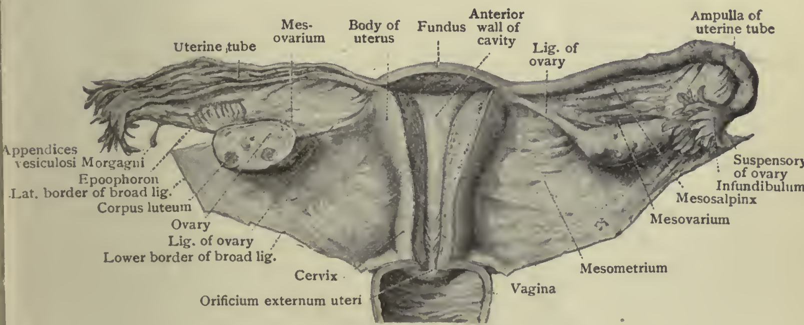


FIG. 231.—The Uterus, with the Broad Ligaments stretching out from its sides.

The Rectum.—A detailed account of the rectum in the male is given on p. 436; the student should read that account and then note the points of difference in the female.

In the upper part of its extent the rectum of the female is separated from the uterus and vagina by the recto-vaginal pouch of peritoneum and the coils of intestine which it contains. Below the bottom of the pouch the rectum is in apposition with the posterior wall of the vagina, the layer of recto-vaginal fascia alone intervening. The connection between the rectal and vaginal walls is very loose above, but is closer below. The arrangement has an important bearing upon the manner in which prolapse of the uterus occurs.

The Anal Canal.—The anal canal bends downwards and backwards from the rectum. It commences about 38 mm.

(one inch and a half) in front of the tip of the coccyx and terminates at the anal orifice. An angular area is thus left between the anterior wall of the canal and the back of the urogenital cleft; it is occupied by a pyramidal mass of firm fibro-muscular tissue called the *perineal body*.

The Blood-vessels of the Pelvis Minor.

The manner in which the blood-vessels of the pelvis minor should be dissected has been described on p. 452. In the female, the dissector will find three arteries which were either not studied at all, or not under the same name, in the dissection of the male pelvis minor, viz.—

1. The uterine, } branches of the hypogastric.
2. The vaginal, }
3. The ovarian, from the abdominal aorta.

Arteria Uterina.—The uterine artery springs either from the anterior division of the hypogastric or from the umbilical artery. It runs downwards, in front of the vertical part of the pelvic portion of the ureter, and then medially along the lower border of the broad ligament and above the lower part of the ureter (Figs. 224, 228). Having crossed the ureter, it passes above the lateral fornix of the vagina and turns upwards along the side of the uterus. It ends by anastomosing with branches of the ovarian artery beneath the isthmus of the uterine tube. It gives branches to the uterus, the vagina, and the isthmus of the uterine tube, and frequently it supplies twigs to the ovary.

Arteria Vaginalis.—The vaginal artery springs from the anterior division of the hypogastric artery. It probably represents the inferior vesical artery of the male, and whilst it is distributed mainly to the vagina it gives twigs also to the base of the bladder and to the rectum.

Arteria Ovarica.—The ovarian artery corresponds to the internal spermatic artery of the male, and the abdominal part of its course is similar to that of the latter artery (p. 392). When it arrives at the pelvis it crosses the *upper part* of the external iliac vessels, and insinuates itself between the two layers of the broad ligament where they form the suspensory ligament of the ovary. It is highly tortuous, and is enclosed, in the terminal part of its extent, in the coils of the *pampiniform plexus* formed by the veins which issue from the hilum of the ovary. Its terminal branches are distributed mainly to the ovary, which they enter at the hilum, but some pass on to anastomose with branches of the uterine artery. It supplies twigs to the uterine tube also.

The remaining arteries of the female pelvis correspond very closely to those of the male, of which descriptions will be found on pp. 454-458.

The Veins of the Pelvis.—Little requires to be said beyond what was stated regarding the veins of the male pelvis minor on p. 458. The pudendal plexus, into which the *dorsal vein of the clitoris* opens, is smaller than in the male, but is connected in a similar manner with the vesical plexus.

A bulky *uterine venous plexus* is formed on each side of the uterus, between the two layers of the broad ligament. The plexus takes part in the formation of the parametrium, and from its lower part the blood is drained away by one or more uterine veins which end in the hypogastric vein.

A *vaginal venous plexus* is also formed around the vagina. It is most dense along each lateral border, in the angle between the vesical and the recto-vaginal layers of the pelvic fascia. One or more *vaginal veins* proceed from its upper end on each side; they end in the hypogastric veins.

A *pampiniform plexus of veins* is formed by the veins which issue from the hilum of the ovary. It lies between the layers of the broad ligament, and from it two *ovarian veins* issue. They accompany the ovarian artery, and ultimately fuse into a single vein which ends in a manner similar to the corresponding internal spermatic vein of the male (p. 392).

The Pelvic Lymph Vessels.—The lymph vessels of the bladder and rectum are the same in the female as in the male (see p. 459); but, in the female, the lymph vessels of the vagina, uterus, uterine tubes, and ovaries, have also to be considered. Lymph vessels from the lower part of the vagina pass to the superficial subinguinal and to the sacral lymph glands. From the middle and upper parts of the vagina and from the cervix uteri they pass to the hypogastric, the external iliac and the sacral lymph glands. From the body of the uterus they pass to the external iliac and hypogastric lymph glands and along the round ligament to the superficial subinguinal lymph glands. The lymph vessels from the upper part of the uterus and from the ovary terminate in the lymph glands around the aorta.

The Visceral Nerves of the Pelvis.

Very little requires to be added to what has already been said about the visceral nerve plexuses (p. 464). There is no *prostatic plexus*; but a *vaginal plexus*, an *ovarian plexus*, and a *uterine plexus* are present in addition to those mentioned in the description of the male pelvis.

The *uterine plexus* proceeds from the pelvic plexus. It ascends between the layers of the broad ligament, along the uterine artery, and is distributed to both aspects of the uterus.

The *vaginal plexus* is also an offset from the pelvic plexus, and the nerves which compose it are derived mainly from the visceral branches which enter the pelvic plexus from the third and fourth sacral nerves.

The *ovarian plexus* is derived from the aortic and renal plexuses. It accompanies the artery of the same name, and is distributed to the ovary.

Dissection.—When the blood-vessels and the visceral nerve plexuses have been examined, the pelvic viscera should be removed. The vessels and nerves passing to them must be cut; the visceral layer of pelvic fascia on the upper surface of the levator ani must be divided, from before backwards, and stripped medially from the upper surface of the muscle. Finally, the rectum must be separated from the upper end of the anal canal, and then the viscera can be removed. When that has been done the structure of the walls of the viscera should be studied.

Structure of the Uterus.—The uterus possesses three well-marked coats—a serous or peritoneal, a muscular and a mucous. The *serous covering* has already been fully studied (p. 495). The *muscular part* of the wall constitutes its chief bulk. It is composed of involuntary muscular tissue, with a considerable admixture of areolar tissue. It is not equally thick throughout, and is relatively thin towards the angles or points where the uterine tubes open into the uterus.

The *mucous membrane* which lines the cavity is not of uniform appearance. In the body of the uterus it is smooth and closely bound to the adjacent muscle. In the cervix it presents a striking arrangement, which from its appearance has been termed the *arbor vitæ*. The arbor vitæ consists of a series of prominent folds or rugæ, called *plicæ palmatæ*, arranged in a definite manner. There is a median fold on the anterior and another on the posterior wall of the canal.

Secondary folds branch off from each median fold and pass obliquely upwards and laterally. The plicæ palmatæ are better marked on the anterior than on the posterior wall. Between the plicæ palmatæ the dissector may discover some minute vesicles filled with yellowish fluid; these are the *ovula Nabothi.* They result from the obstruction of the mouths and the distension of the cavities of certain tubular glands which lie in the mucous membrane.

The Coats of the Vagina.—The vagina possesses an external muscular coat, an internal mucous coat, and an intermediate layer of cavernous tissue. The muscular coat is formed of unstriped muscle fibres arranged in two layers, an external longitudinal layer and an internal circular layer, of which the former is much the stronger. The mucous membrane presents two well-marked median longitudinal folds, one on the anterior, and one on the posterior wall. They are termed the *columnæ rugarum*, and from each side they send off numerous transverse ridges, which are arranged so that those of the anterior wall fit in between those on the posterior wall. The folds are best marked near the vaginal orifice, and are absent at the upper part of the canal. The intermediate layer of cavernous tissue is thin.

Structure of the Uterine Tubes.—Each uterine tube has an external serous, an intermediate muscular, and an internal mucous lining coat. The serous coat is the peritoneal covering formed by the layers of the broad ligament. The muscular coat consists of an external longitudinal and an internal circular layer of unstriped muscle fibres. The tube is so narrow in the region of the isthmus that the mucous membrane in that region can be satisfactorily examined only in sections and with the aid of the microscope, but the ampulla is easily opened, and when that has been done the dissector will recognise that the mucous membrane is arranged in longitudinal folds. To obtain a proper idea of the fimbriæ the tube should be immersed in water, when they will float out and separate from each other.

The Coats of the Rectum and Anal Canal.—The coats of these portions of the intestinal canal are identical in both sexes. The student should refer, therefore, to p. 466, where the walls of the male rectum and anal canal are described.

Dissection.—When the dissector has completed his study of the structure of the pelvic viscera he should return to the

investigation of the pelvic spinal nerve plexuses, and the sympathetic trunk, and the coccygeal glomus (see p. 461). After he has satisfied himself regarding the formation and distribution of the plexuses, and the position and connections of the sympathetic trunk, he should study the pelvic diaphragm.

The sacral, the pudendal, and the coccygeal nerve-plexuses are the same in both sexes, and the description of their constitution and relations will be found on pp. 461 and 462.

The pelvic portions of the sympathetic trunks are described on p. 464.

The position and constitution of the coccygeal glomus are given on p. 465.

The Pelvic Diaphragm.

The pelvic diaphragm is described on pp. 459, 460. The dissector should note that the levator ani muscle passes downwards and backwards and that it gives support to the lateral border of the vagina; he should note also that the anterior borders of the two levatores ani muscles embrace the lower part of the vagina very closely, and exert a sphincter action upon it.

***Dissection.*—After he has studied the pelvic diaphragm the dissector should remove the levator ani to display the obturator internus, and examine the attachment and arrangement of that muscle (see p. 468). He should then study the piriformis (see p. 468), and should complete his dissection of the pelvis by an examination of the pelvic articulations.**

The Pelvic Articulations.—The pelvic joints are described at p. 469. In the later months of pregnancy the ligamentous structures of the various pelvic joints become softened and thickened by the infiltration of fluid. The pelvic bones are thus separated from each other to some extent, and the calibre of the pelvic canal is increased, in preparation for the passage of the child.

INDEX.

orning -
Globulin is almost insol in NaCl,
heat increases sol. - Coag at 65

du. Exp.
P.108 - Edestin - Exp. 1-2-3-4-5
P109 1-2-3-4-5.

END OF VOL. II

P118 - "Peptones" Exp 1-2

P119 Exp 1-2-3
Sep. of ~~[illegible]~~ proteoses etc. Exp
1-2-3-4-5-6-7

CUNNINGHAM'S MANUAL

OF

PRACTICAL ANATOMY

REVISED AND EDITED BY

ARTHUR ROBINSON

PROFESSOR OF ANATOMY IN THE UNIVERSITY OF EDINBURGH

SEVENTH EDITION

VOLUME THIRD

HEAD AND NECK

WITH 233 ILLUSTRATIONS, MANY OF WHICH ARE COLOURED

NEW YORK

WILLIAM WOOD AND COMPANY

EDINBURGH, GLASGOW, AND LONDON

HENRY FROWDE AND HODDER & STOUGHTON

1921

Printed in Great Britain by R. & R. CLARK, LIMITED, *Edinburgh.*

1st Edition, 1896.
2nd Edition, 1903.
3rd Edition, 1906.
4th Edition, 1907.
5th Edition, 1912.
6th Edition, 1914.
6th Edition, 2nd Impression, 1917.
6th Edition, 3rd Impression, 1918.
7th Edition, 1920.
7th Edition, 2nd Impression, 1921.

PREFACE TO THE SEVENTH EDITION

In this edition the general text has been revised, many new figures, representing dissections, sections and radiographs, have been introduced. The instructions for dissection have been printed in a distinctive indented type; in many cases they have been rewritten and in some cases amplified.

The latter changes, together with the additional figures, have caused so much increase of size that it has been deemed advisable to publish the book in three volumes. Vol. I.: Superior Extremity and Inferior Extremity; Vol. II.: Thorax and Abdomen; Vol. III.: Head and Neck.

As was the case in previous editions, I am indebted to Dr. E. B. Jamieson for many suggestions, for his invaluable help in the revision of the text and for the preparation of the Index.

My thanks are due to Dr. Robert Knox, to Major A. W. Pirie and to Major T. Rankin for the use of radiographs, which they very kindly prepared for me, and to Mr. J. T. Murray for the new drawings of sections and dissections.

ARTHUR ROBINSON.

Oct. 11, 1919.

CONTENTS

HEAD AND NECK.

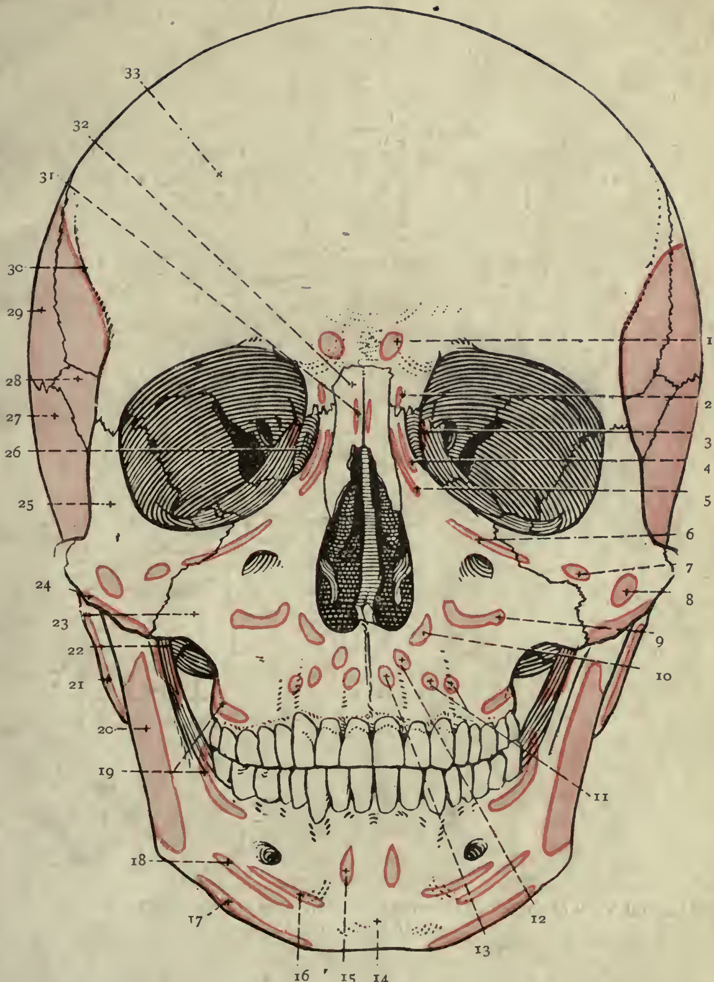
ENCEPHALON—THE BRAIN.

THE AUDITORY APPARATUS.

BULBUS OCULI.

Anterior View of the Skull (Norma frontalis), showing the bones and the muscular attachments.

1. M. orbicularis oculi, *upper frontal attachment* (*corrugator supercilii*).
2. M. orbicularis oculi, *lower frontal attachment.*
3. M. orbicularis oculi (tensor tarsi), *lacrimal attachment.*
4. M. orbicularis oculi, *maxillary attachment.*
5. M. quadratus labii superioris, *angular part.*
6. M. quadratus labii superioris, *infra-orbital part.*
7. M. quadratus labii superioris, *zygomatic part.*
8. M. zygomaticus, *on zygomatic bone.*
9. M. caninus, *on maxilla.*
10. M. nasalis, *pars transversa.*
11. M. incisivus labii superioris.
12. M. nasalis, *pars alaris.*
13. M. depressor septi.
14. Symphysis of mandible.
15. M. mentalis, *on body of mandible.*
16. M. quadratus labii inferioris, *on body of mandible.*
17. M. platysma, *on body of mandible.*
18. M. triangularis, *on body of mandible.*
19. M. buccinator, *on alveolar processes of maxilla and mandible.*
20. M. masseter, *insertion, on ramus of mandible.*
21. M. sterno-mastoid, *on mastoid process of temporal bone.*
22. M. temporalis, *insertion, on ramus of mandible.*
23. Maxilla.
24. M. masseter, *origin, on zygomatic and temporal bones.*
25. Zygomatic bone.
26. Lacrimal bone.
27. Squamous part of temporal bone, *and origin of M. temporalis.*
28. Great wing of sphenoid bone, *and origin of M. temporalis.*
29. Parietal bone, *and origin of M. temporalis.*
30. Temporal line, *and upper limit of origin of M. temporalis on frontal and parietal bones.*
31. M. procerus, *on nasal bone.*
32. Nasal bone.
33. Frontal bone.



Anterior View of the Skull (Norma frontalis), showing the bones and the muscular attachments.

Lateral View of the Skull (Norma lateralis), showing the bones and the muscular attachments.

Lateral View of the Skull (Norma lateralis), showing the bones and the attachments of muscles.

1. Coronal suture.
2. Frontal bone.
3. Great wing of sphenoid bone, *and origin of temporal muscle.*
4. Zygomatic bone.
5. M. orbicularis oculi, *upper frontal origin* (*corrugator supercilii*).
6. M. orbicularis oculi, *lower frontal origin.*
7. M. orbicularis oculi (tensor tarsi), *lacrimal attachment.*
8. M. procerus, *on nasal bone.*
9. M. orbicularis oculi, *maxillary origin.*
10. M. quadratus labii superioris, *angular part.*
11. M. quadratus labii superioris, *infra-orbital part, on maxilla and zygomatic bone.*
12. M. quadratus labii inferioris, *zygomatic part, on zygomatic bone.*
13. M. zygomaticus, *on zygomatic bone.*
14. M. caninus, *on maxilla.*
15. M. nasalis, *pars transversa.*
16. M. nasalis, *pars alaris.*
17. M. depressor septi.
18. M. incisivus labii superioris, *on maxilla.*
19. M. incisivus labii inferioris, *on maxilla.*
20. M. mentalis, *on body of mandible.*
21. M. quadratus labii inferioris, *on body of mandible.*
22. M. triangularis, *on body of mandible.*
23. M. platysma, *on body of mandible.*
24. M. buccinator, *on alveolar processes of maxilla and mandible.*
25. M. masseter, *insertion on ramus of mandible.*
26. M. temporalis, *insertion on coronoid process of mandible.*
27. M. masseter, *origin on zygomatic and temporal bones.*
28. M. stylo-glossus, *on styloid process of temporal bone.*
29. M. stylo-hyoid, *on styloid process of temporal bone.*
30. M. auricularis posterior, *on post-auditory part of squamous portion of temporal bone.*
31. M. longissimus capitis, *on mastoid portion of temporal bone.*
32. M. sterno-mastoid, *on mastoid part of temporal bone and squamous part of occipital bone.*
33. M. splenius capitis, *on mastoid part of temporal bone and squamous part of occipital bone.*
34. M. trapezius, *on superior nuchal line of occipital bone.*
35. M. occipito frontalis, *occipital part, on superior nuchal line of occipital bone.*
36. Squamous part of occipital bone.
37. Lambda.
38. Squamous part of temporal bone, *and origin of M. temporalis.*
39. Parietal bone.
40. Inferior temporal line, *and upper limit of origin of M. temporalis on parietal and frontal bones.*
41. Superior temporal line, *and upper attachment of temporal aponeurosis.*

MANUAL

OF

PRACTICAL ANATOMY.

HEAD AND NECK.

THE dissectors of the Head and Neck begin work as soon as the subject is brought into the room. During the first three days, whilst the body is in the lithotomy posture, they dissect the face, the anterior part of the eyelids, the superficial part of the nose, and the anterior part of the scalp. During the following five days, when the body is lying on its back, they dissect the posterior triangle, and complete the dissection of the scalp.

It is only by dissecting the face at this period, whilst the parts are in good condition, that the dissector can gain any satisfactory idea of its component parts; and it is essential that the contents of the posterior triangle, which is such an important surgical region, should be displayed before the dissector of the arm has disturbed its posterior boundary.

The *first day* should be devoted to the examination of the anterior part of the frontal region of the head and the face, the study of the surface anatomy of the ocular appendages, the reflection of the skin and the cleaning of the superficial muscles of the face and anterior part of the scalp. On the *second day* the dissectors should display the superficial surface of the parotid gland; they should also find and clean the superficial vessels and nerves, and trace them to their terminations. On the *third day* the superficial muscles must be reflected, and the deeper vessels and nerves must be exposed and cleaned, and the auricle should be examined and dissected. On the *fourth day* the body is placed upon its back, and the dissectors should commence the dissection of the posterior triangle of the neck; they must complete that part of the dissection in three days. On the *seventh day* they should complete the examination of the scalp. The *eighth day* should be devoted to a final study of the brachial plexus, in association with the dissectors of the upper extremity.

FACE AND FRONTAL REGION OF HEAD.

The dissectors should commence the study of the face and frontal region by an examination of the bony prominences and ridges in the area to be dissected.

In the centre of the facial area is the prominent outer portion of the nose, consisting of a lower mobile part, formed mainly by skin and cartilage, and an upper rigid portion, formed by the nasal bones and the frontal processes of the maxillæ. At the sides of the nose are the sockets for the eyeballs, each of which is bounded above by the supra-orbital margin of the frontal bone and below by the orbital margins of the maxilla and the zygomatic bone (O.T. malar). The supra- and infra-orbital margins meet laterally in the region of the cheek bone (zygomatic). From the posterior part of the zygomatic bone, the zygomatic arch, formed partly by the zygomatic and partly by the temporal bone, extends barkwards to the ear. Above the zygomatic arch is the region of the temporal fossa, which is bounded superiorly by the temporal line. The line terminates anteriorly in the lateral part of the supra-orbital margin. Above the medial part of the supra-orbital margin the superciliary arch can be felt, and at a higher level, above the lateral part of the supra-orbital margin, lies the frontal tuberosity. The region above the nose and between the medial ends of the superciliary arches is the *glabella*.

Below the zygomatic arch lies the ramus of the mandible, covered by the masseter muscle; and extending forwards from the lower end of the ramus is the body of the mandible. A line dropped vertically through the junction of the medial third with the lateral two-thirds of the supra-orbital margin, will cut through the supra-orbital notch of the frontal bone, the infra-orbital foramen of the maxilla, and the mental foramen of the mandible, all three of which may be felt if firm pressure is made in the proper situations. The first, which lies in the supra-orbital margin, transmits the supra-orbital vessels and nerve. The second is placed about half an inch below the infra-orbital margin; it transmits the infra-orbital vessels and nerve. The third lies midway between the second premolar tooth of the mandible and the lower border of the mandible; it transmits the mental branches of the inferior alveolar vessels and nerve.

After the bony points of the region have been studied, the surface anatomy of the ocular appendages should be examined. Under this head are included—(1) the eyebrows; (2) the eyelids; (3) the conjunctiva.

The *eyebrows* are two curved tegumentary projections placed over the supra-orbital arches of the frontal bone; they intervene between the forehead above and the ocular regions below. The short stiff hairs which spring from the eyebrows have a lateral inclination.

The *eyelids* (palpebræ) are the semilunar curtains provided for the protection of each eyeball. The upper lid is the longer and much the more movable of the two. When the eye is open, the margins of the two lids are slightly concave and the interval between them, *rima palpebrarum*, is elliptical in outline. When the eye is closed, and the margins of the lids are in apposition, the rima palpebrarum is reduced to a nearly horizontal line. Owing to the greater length and mobility of the upper lid, the rima, in the closed condition, is placed at the level of the lower border of the cornea, which is the transparent front part of the eyeball.

At the extremities of the rima palpebrarum the eyelids meet and form the *palpebral commissures*. Immediately lateral to the medial commissure the rima expands into a small triangular space, called the *lacus lacrimalis*. If the dissector now examines the free margins of the lids he will note that, to the lateral side of the lacus lacrimalis, they are flat, and that in each lid the *cilia* or eyelashes project from the anterior border, whilst the tarsal glands open, by a series of minute apertures, along the posterior border, a distinct interval intervening between the cilia and the mouths of the glands. On the other hand, the small portion of the margin of each eyelid which bounds the lacus lacrimalis is more horizontal in direction and somewhat rounded. It is destitute both of eyelashes and of tarsal glands. At the very point where the eyelashes in each eyelid cease, and the palpebral margin becomes rounded, a small eminence, with a central perforation, will be seen. The

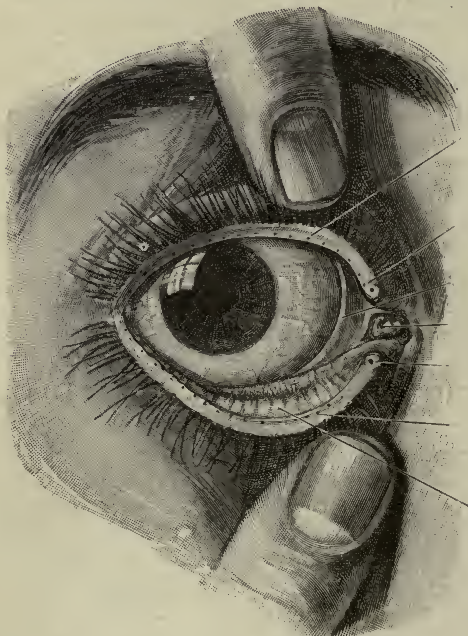


FIG. 1.—Eyelid slightly everted to show the Conjunctiva (enlarged).

eminence is the *papilla lacrimalis*, whilst the perforation, called the *punctum lacrimale*, is the mouth of a *lacrimal duct*, which conveys away the tears. Endeavour to pass a bristle into each of the orifices. The upper duct at first ascends, whilst the lower one descends, and then both run horizontally to the lacrimal sac, which lies in a depression in the medial wall of the orbit.

The *conjunctiva* is the membrane which lines the deep surfaces of the lids. It is reflected from them on to the anterior aspect of the eyeball. At the margins of the lids it is continuous with the skin, whilst, through the puncta lacrimalia and the lacrimal ducts, it becomes continuous with the lining membrane of the lacrimal sac. The line of reflection of the conjunctiva from each of the eyelids on to the eyeball is termed a *fornix conjunctivæ*. Owing to the greater vertical extent of the upper lid, the conjunctival recess between the upper lid and the eyeball is larger than that behind the lower lid. The conjunctiva is loosely connected with the eyelids on the one hand, and with the sclera, or white part of the eyeball, on the other. Over the cornea the membrane becomes thinned down to a mere epithelial covering, which forms the epithelium of the cornea.

In connection with the conjunctiva, the *plica semilunaris* and the *caruncula lacrimalis* must be examined. The caruncula is the reddish, fleshy-looking elevation which occupies the centre of the lacus lacrimalis. From its surface a few minute hairs project. The plica semilunaris is of interest because it is the rudimentary representative, in the human eye, of the membrana nictitans, or third eyelid, found in many animals. It is a small vertical fold of conjunctiva, which is placed immediately to the lateral side of the caruncula, and it slightly overlaps the eyeball at that point (Fig. 1).

Dissection.—Distend the eyelids slightly by placing a little tow or cotton wool, steeped in preservative solution, in the conjunctival sac; then stitch the margins of the lids together. Distend the cheeks and lips slightly by placing tow or cotton wool, steeped in preservative solution, in the vestibule of the mouth—that is, between the cheeks and lips externally and the teeth and gums internally; then stitch the red margins of the lips together.

Reflect the skin by means of three incisions, a median longitudinal and two transverse. Commence the median incision midway between the root of the nose and the external occipital protuberance, carry it forwards to the forehead and then downwards along the median line of the forehead, the nose and the lips, to the tip of the chin. Commence the upper horizontal incision at the level of the rima palpebrarum; carry it laterally from the longitudinal incision to the medial commissure, then round the margins of the rima to the lateral commissure, and, finally, backwards to the ear. The lower horizontal incision should run from the angle of the mouth to the posterior border of the ramus of the mandible. Reflect the upper and middle flaps and leave them attached posteriorly. Reflect the lower flap downwards to the lower border of the mandible. Note, whilst reflecting the skin, that many of the superficial fibres of the facial muscles are implanted into its deep surface. It is those fibres which tend to displace the margins of wounds of the face, and necessitate the application of numerous and firmly tied sutures in order to secure quick and accurate union. Whilst reflecting the skin the dissector must be careful to keep his knife playing against its deep surface; otherwise he is certain to injure the sphincter muscle of the eyelids, and the superficial extrinsic muscles of the ear which lie in the temporal region.

After the skin is reflected, clean the superficial muscles. That which will first attract attention is the orbicularis oculi, around the orbit. Above the orbicularis oculi is the frontal belly of the epicranial muscle. To the medial side of the orbicularis oculi lie the muscles of the nose. Below the eye the muscles of the upper lip pass downwards to the orbicularis oris and the mouth. Passing forwards and upwards, over the posterior part of the lower border of the mandible, are the upper and posterior fibres of the platysma, and more medially are the muscles of the lower lip (Fig. 2).

Commence with the *orbicularis oculi* (O.T. orbicularis palpebrarum), which lies in and around the region of the eyelids. Pull the eyelids laterally and note a prominent cord-like band which extends from the frontal process of the maxilla to the medial commissure, where it becomes continuous with both eyelids; it is the *medial palpebral ligament* (O.T. internal tarsal ligament). A somewhat similar band, the *lateral palpebral raphe* (O.T. external tarsal ligament), extends from the lateral commissure to the zygomatic bone. After the medial palpebral ligament has been recognised, clean first the thicker *orbital part* of the orbicularis oculi, which covers the superficial bony boundaries of the orbit, and then the thinner *palpebral portion*, which lies in the eyelids. The palpebral part is not only thin but also pale, and its fibres, in each eyelid, sweep in gentle curves from the medial palpebral ligament to the lateral palpebral raphe, gaining attachment to both.

Next clean the *orbicularis oris*, which surrounds the mouth, and take care not to injure the other muscles of the lips which blend with the margins of the orbicularis oris. Attempt to define the *depressor septi nasi* which springs from the middle of the upper border of the orbicularis oris and is inserted into the lower part of the septum of the nose (Fig. 2).

After the two orbicular muscles have been cleaned, turn to the *frontal belly of the epicranius*, which lies above the orbicularis oculi. Its fibres run upwards and backwards from the orbicularis oculi, with which it blends, to the tendinous sheet called the galea aponeurotica, which covers the vertex of the skull and connects the frontal belly with the occipital belly of the muscle. The edge of the knife must be kept parallel with the fibres of the muscle, and as the cleaning proceeds avoid injuring the branches of the supra-orbital nerve and artery which pierce the muscle. From the medial margin of the frontal belly of the epicranius trace a small bundle of muscle fibres, called the *procerus*, downwards to the dorsum of the nose, and at the same time secure the supra-trochlear nerve and the frontal branch of the ophthalmic artery which pierce the muscle at the medial part of the upper margin of the orbit. Below the procerus secure the *angular head of the quadratus labii superioris*, a muscular slip which springs from the frontal process of the maxillary bone, and trace it downwards to the orbicularis oris, but avoid injury to the angular vein which lies on its superficial surface. Medial to the angular head of the quadratus labii superioris find and clean the *pars transversa* of the *musculus nasalis*, which lies across the lower part of the bridge of the nose. Below the pars transversa it may be possible to display the *pars alaris* which passes from the maxilla to the ala of the nose.

Now turn to the lower border of the mandible and clean the platysma, a broad thin sheet of muscle which ascends from the neck. Its anterior fibres are inserted into the anterior part of the lower border of the mandible. The posterior fibres ascend across the mandible, then they turn forwards to the angle of the mouth, as the *risorius*. Above and in front of the risorius find the *zygomaticus*, a slender muscle which descends from the zygomatic bone to the angle of the mouth, where it blends with the orbicularis oris. Now follow the angular vein downwards and backwards. At the lower margin of the orbit it becomes the anterior facial vein; follow that vein downwards and backwards to the point where it disappears under cover of the zygomaticus. Below and in front of the anterior facial vein the terminal part of the external maxillary artery may be found on the superficial surface of the quadratus labii superioris, but it may lie deep to that muscle. After the anterior facial vein has been cleaned, in the area indicated, raise the lower fibres of the orbicularis oculi and reflect them towards the palpebral fissure; then clean the *infra-orbital head* of the quadratus labii superioris, a flat and fairly wide muscle which springs from the lower margin of the orbit, under cover of the orbicularis oculi, and descends to the upper lip, where it blends with the orbicularis oris. Lateral to the infra-orbital head, the small *zygomatic head* of the quadratus labii superioris may be found. It descends from the zygomatic bone and blends with the lower part of the lateral border of the infra-orbital head. After the zygomatic head has been cleaned turn to the lower lip region and clean the *triangularis*. It springs from the mandible above the insertion of the anterior part of the platysma and passes upwards to the angle of the mouth, where it blends with the orbicularis oris. Anterior to the triangularis, and on a deeper plane, find and clean the *quadratus labii inferioris*. It springs from the mandible under cover of and anterior to the triangularis and ascends to the orbicularis oris, with which it blends. After the muscles mentioned have been defined proceed to the detailed study of their positions and attachments.

Orbicularis Oculi.—The orbicular muscle of the eyelids, on each side, consists of a thick orbital portion which covers the superficial bony boundaries of the orbit, and a thinner and paler palpebral part which lies in the eyelids.

The *orbital portion* of the muscle extends upwards to the forehead, laterally to the temporal region and downwards into the cheek. Its fibres are relatively dark and coarse. They all take origin medially from the medial part of the palpebral ligament, the adjoining part of the frontal bone, and the frontal process of the maxilla, and they sweep laterally round the margin of the orbit in the form of a series of concentric loops. The upper fibres blend with the frontal belly of the epicranius, and the lower fibres overlap the upper parts of the muscles of the upper lip. Some of the fibres spring from the nasal part of the frontal bone and terminate in the skin of the eyebrow.

The palpebral part consists of fibres which sweep in gentle curves from the medial palpebral ligament to the lateral palpebral raphe, to both of which they are attached. Peripherally they blend with the orbital part, and they form a continuous layer of uniform thickness, except near the free margins, where, close to the bases of the eyelashes, there is a more pronounced fasciculus, termed the *ciliary bundle.* Some of the fibres of the palpebral portion pass from the deep surface of the medial palpebral ligament to the lacrimal bone; they constitute the *pars lacrimalis*, which will be described when the eyelids are dissected (see p. 29).

The orbicularis oculi is supplied by the facial nerve. It closes the eyelids and compresses them against the eyeball. The pars lacrimalis helps to force the lacrimal secretion from the lacrimal sac into the naso-lacrimal duct. Those fibres of the orbital part of the muscle which spring from the nasal process of the frontal bone and terminate in the skin of the eyebrow pull the eyebrow towards the median plane, and throw the skin of the central part of the forehead into vertical folds; they were at one time described as a separate muscle which was called the *corrugator supercilii.*

Musculus Epicranius (O.T. **Occipito-Frontalis**).—The epicranius is a quadricipital muscle possessing two occipital heads, the occipitales muscles, and two frontal heads, the frontales muscles; they are all inserted into an intermediate aponeurosis, the *galea aponeurotica* (O.T. *epicranial aponeurosis*), which extends from the frontal to the occipital region (p. 50). The lower part of each frontal head blends with the orbicularis oculi, and from its medial border a small muscular bundle, known as the *musculus procerus* (O.T. *pyramidalis nasi*), descends to the dorsum of the nose. At present only the frontalis and the procerus have been displayed (Fig. 2).

The **Frontalis** becomes apparent immediately above the upper border of the orbicularis oculi. As it is cleaned care should be taken to avoid injury to the branches of the supra-orbital nerve which pierce it. It has little or no attachment to bone. Below, its fibres either blend with the fibres of the orbicularis oculi or they are attached to the skin of the eye-brows. Above, they terminate in the galea aponeurotica, in the region of the coronal suture. The lateral border is attached to the temporal ridge by aponeurotic fibres, and the medial border blends with its fellow of the opposite side for a short distance above the root of the nose. Above the union the medial fibres of opposite sides diverge, and below it they pass downwards over the nasal bones as the proceral muscles. The frontalis pulls the scalp forwards. It is supplied by the facial nerve.

Musculus Procerus (O.T. **Pyramidalis Nasi**).—The proceral muscles are often absent; when present, each springs from the lower and medial part of the corresponding frontalis. It descends over the nasal bone and ends on the dorsum of the nose, where some of its fibres blend with the trans-verse part of the nasalis and others are inserted into the skin. It is supplied by the facial nerve.

Along the lower and medial border of the orbicularis oculi will be found the muscles of the nose and the upper lip.

The proper muscles of the nose are the musculus nasalis and the musculus depressor septi, but the procerus also may be looked upon as partly a nasal muscle, and the angular head of the quadratus labii superioris has a nasal attachment.

Musculus Nasalis.—The musculus nasalis consists of two parts, the *pars transversa* (O.T. *compressor naris*) and the *pars alaris* (O.T. *dilator naris*). The pars transversa springs from the root of the frontal process of the maxilla, passes across the cartilaginous part of the nose, above the ala, and ends in an aponeurosis which connects it with its fellow of the opposite side. The pars alaris springs from the maxilla, at the side of the lower part of the anterior nasal aperture, and it terminates in the posterior part of the ala and the mobile part of the septum of the nose. The nasalis is partly concealed by the angular head of the quadratus labii superioris.

The transverse part, acting with its fellow of the opposite side, depresses the dorsum of the nose and compresses its sides. The pars alaris dilates the nostril of the same side. Both parts are supplied by the facial nerve.

Musculus Depressor Septi Nasi.—The depressor of the nasal septum is frequently difficult to display. It springs from the superficial fibres of the upper part of the orbicularis oris, and is inserted into the anterior part of the septum of the nose. It depresses the septum and reduces the antero-posterior diameter of the anterior nasal aperture. The name indicates the action of the muscle, which is supplied by the facial nerve.

The Muscles of the Mouth and Cheeks.—The muscles of this group form two layers, a superficial and a deep. Those of the superficial group are the orbicularis oris, quadratus labii superioris, zygomaticus, triangularis, risorius, quadratus labii inferioris; those of the deeper group are the buccinator, caninus, incisivus superior and inferior, and the mentalis. All, with the exception of the orbicularis oris, are bilateral. Only the members of the superficial group are at present displayed; the deeper muscles will be dissected after the superficial vessels and nerves have been cleaned and studied.

Orbicularis Oris.—The orbicularis oris is the sphincter muscle of the oral aperture. It lies in the substance of the lips, and consists of a deeper layer of fibres which are arranged in concentric ellipsoidal rings, and a series of superficial fibres into which all the other muscles of the lips and cheeks converge. The details of its formation cannot be understood until the attachments of the other muscles have been studied (see p. 21). It is supplied by the facial nerve.

Musculus Quadratus Labii Superioris.—The quadratus labii superioris possesses three heads—a zygomatic, an infra-orbital, and an angular.

The *zygomatic head* (O.T. *zygomaticus minor*) springs from the anterior part of the facial surface of the zygomatic bone, under cover of the lower lateral part of the orbicularis oculi. It runs downwards and forwards, and either joins the infra-orbital head or is inserted into the lateral part of the upper portion of the orbicularis oris and into the adjacent part of the skin of the upper lip.

The infra-orbital head (O.T. *levator labii superioris proprius*) arises from the whole length of the infra-orbital border, under cover of the orbicularis oculi. It is inserted into the upper lateral part of the orbicularis oris and the skin of the upper lip (Fig. 2).

The *angular head* (O.T. *levator labii superioris alæque nasi*) springs from the frontal process of the maxilla. It broadens as it descends, and it is inserted into the ala of the nose and into the upper part of the orbicularis oris.

The quadratus labii superioris raises the upper lip, and its

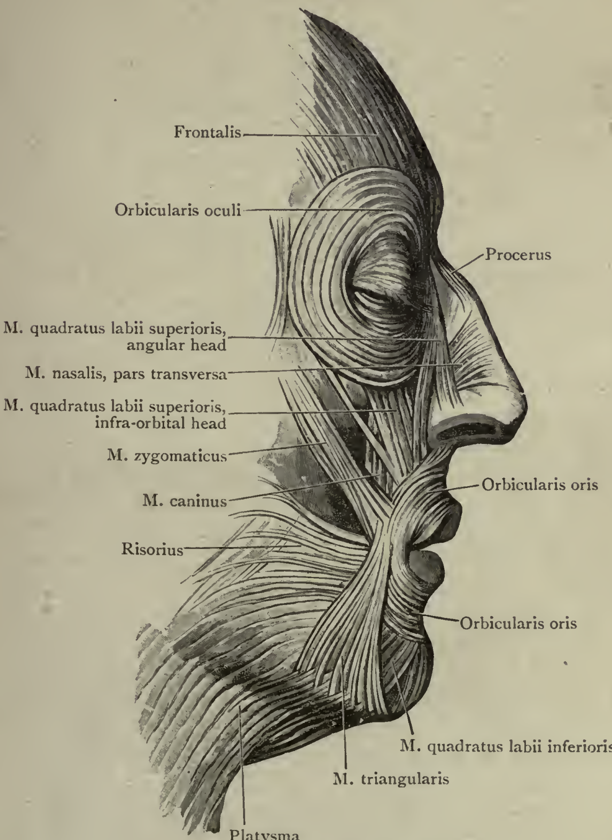


FIG. 2.—The Facial Muscles.

angular head elevates the ala of the nose. It is supplied by the facial nerve.

Musculus Zygomaticus.—The zygomaticus (O.T. zygomaticus major) is a comparatively long, slender muscular band which springs from the facial surface of the zygomatic bone, under cover of the lower lateral fibres of the orbicularis oculi and to the lateral side of the zygomatic head of the quadratus labii superioris. Its fibres pass downwards and medially to the angle of the mouth, where some blend with the orbicularis oris and others are inserted into the skin. It pulls the angle of the mouth upwards and backwards. It is supplied by the facial nerve.

The Risorius.—When well developed the risorius muscle consists partly of some of the uppermost fibres of the platysma muscle of the neck, which bend forwards and medially to the angle of the mouth, and partly of additional fibres which spring from the fascia over the masseter muscle and the parotid gland. Both groups of fibres blend with the fibres of the orbicularis oris at the angle of the mouth. The risorius depresses the angle of the mouth and draws it backwards. It is supplied by the facial nerve.

Musculus Triangularis.—The triangularis (O.T. depressor anguli oris) springs from the oblique line on the lateral surface of the body of the mandible. Its fibres converge as they pass forwards and upwards, and, at the angle of the mouth, they blend with the orbicularis oris, in which some of them curve past the angle and terminate in the substance of the upper lip (Figs. 2, 3). It depresses the angle of the mouth, and is supplied by the facial nerve.

Musculus Quadratus Labii Inferioris (O.T. **Depressor Labii Inferioris**).—The quadrate muscle of the lower lip springs from the lower part of the superficial surface of the mandible, between the mental tubercle and the mental foramen, its posterior border being overlapped by the triangularis. The fibres pass upwards and medially, some to blend with the orbicularis oris and others to gain attachment to the skin of the lower lip. It depresses the lower lip, and is supplied by the facial nerve.

Platysma.—Only the upper part of the broad, flat, quadrangular subcutaneous muscle of the neck is at present visible. The posterior fibres ascend over the lower border of the ramus and the posterior part of the lower border of the body of the mandible, and they have already been seen taking part in the formation of the risorius. The anterior fibres gain direct insertion into the anterior part of the lower border of the body of the mandible. The latter attachment is the only bony attachment which the muscle possesses, all its other attachments being either to fascia or to skin.

It helps to depress the mandible and is supplied by the facial nerve.

Dissection.—Cut through the posterior half of the platysma along the lower border of the mandible; detach the risorius from the fascia on the masseter; then turn the risorius and the detached part of the platysma towards the angle of the mouth. Whilst doing that be careful to avoid injuring the branches of the vessels and nerves of the face (Figs. 4, 5, 15).

As soon as the platysma and the risorius are reflected search below the level of the ear for branches of the great auricular

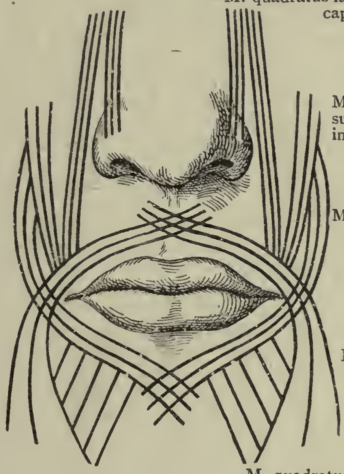


FIG. 3.—Diagram of the Orbicularis Oris Muscle.
The fibres which enter it from the buccinator are not represented.

nerve which ascend over the lower part of the parotid gland. Some of them pierce the parotid and terminate in its substance, others end in the skin of the masseteric region.

Find the anterior facial vein and the external maxillary artery at the lower and anterior angle of the masseter, as they cross the lower border of the mandible. Clean them at that point, but do not trace them towards their terminations at present.

At the posterior border of the mandible note the deep fascia over the superficial surface of the parotid gland; it is called the parotid fascia. It ascends from the fascia of the neck, and is attached above to the zygomatic arch. Note also that at the anterior border of the parotid the parotid fascia blends with the fascia on the superficial surface of the masseter muscle. Cut through the fascia covering the parotid gland immediately anterior to the ear, extending the incision from the zygoma above to the angle of the mandible below; then raise the fascia from the gland, dissecting carefully forwards, upwards, and downwards. As the extremities and the anterior border of the gland are approached, look carefully for nerves and vessels which emerge from beneath them, and also for the duct of the gland, which appears from under cover of the anterior border about a finger's breadth below the zygoma. The duct has thick walls, is of considerable size, and is easily recognised. It runs forwards across the masseter and turns round the anterior border of the muscle, bending at right angles to its original course. It pierces, in turn, the fascia covering the buccinator muscle, the buccinator muscle itself and the mucous membrane of the mouth ; and it opens into the vestibule of the mouth, on a small papilla, opposite the second molar tooth of the maxilla. Above the duct and below the zygomatic arch find—(1) the accessory parotid, a small detached part of the parotid which lies a short distance in front of the anterior border of the main mass of the gland ; (2) the transverse facial vessels ; and (3) the zygomatic branches of the facial nerve. Below the duct find the buccal and the mandibular branches of the facial nerve. At the upper end of the parotid seek for the superficial temporal vessels. Posterior to them lies the auriculo-temporal branch of the third division of the trigeminal nerve, and anterior to them, the temporal branches of the facial nerve. From the lower extremity of the gland emerge—(1) the cervical branch of the facial nerve, (2) the posterior facial vein (O.T. anterior division of the temporo-maxillary vein), and (3) a tributary of the external jugular vein (Fig. 15).

Follow the temporal branch of the facial nerve upwards and forwards to the frontal belly of the epicranius and the upper part of the orbicularis oculi. As the temporal branch is cleaned the anterior part of the strong *temporal fascia* will be exposed. It is attached to the upper border of the zygomatic arch, the posterior border of the zygomatic bone, and the temporal line on the frontal bone. Springing from it, above the posterior part of the zygoma, is the *anterior muscle of the auricle*, and at a higher level the *superior muscle of the auricle*. Attempt to define both the muscles and the branches which pass to them from the temporal division of the facial nerve. A short distance behind a prominent tubercle, which can be felt on the posterior border of the zygomatic bone, the zygomatico-temporal branch of the maxillary division of the trigeminal nerve pierces the temporal fascia and communicates with the temporal branch of the facial nerve. An attempt should be made to secure the zygomatico-temporal nerve and to define the connection.

Further dissection is required before the zygomatic buccal and mandibular branches of the facial nerve can be traced to their terminations. As the dissection proceeds the deeper muscles of the face, branches of the trigeminal nerve and the internal maxillary artery will be exposed, whilst at the same time the externally maxillary artery and its branches and the anterior facial vein and its tributaries must be cleaned.

Follow the upper zygomatic branches of the facial nerve forwards to their termination in the lateral part of the orbicularis oculi, then reflect that muscle towards the median plane and under cover of it, emerging from the zygomatic bone, find the *zygomatico-facial branch* of the maxillary division of the trigeminal nerve. It communicates with one of the zygomatic twigs of the facial nerve. Next follow the lower zygomatic branches of the facial nerve forwards to the zygomaticus muscle, and note that one of the twigs supplies it; then detach the zygomaticus from its origin, turn it down to the angle of the mouth. When that has been done detach the zygomatic and infra-orbital parts of the quadratus labii superioris from their origins and turn them downwards. Now follow the anterior facial vein and the external maxillary artery forwards and upwards to the nose, and secure the branches of the artery. Some of the smaller branches pass backwards, but the main branches, the *inferior* and *superior labial*, pass forwards into the lower and upper lips respectively, where they lie deep to the orbicularis oris against the mucous membrane. Beyond the angle of the mouth the *lateral nasal branch* arises, and the continuation of the external maxillary artery beyond that branch is called the *angular artery*.

After the external maxillary artery and its branches have been cleaned follow the lower zygomatic branches of the facial nerve forwards through the fat exposed by the reflection of the zygomaticus and the quadratus labii superioris, and secure their connections with the terminal branches of the infra-orbital branch of the maxillary division of the trigeminal nerve, which issues through the infra-orbital foramen accompanied by the infra-orbital branch of the internal maxillary artery. The interlacement of the zygomatic branches of the facial nerve with the infra-orbital nerve constitutes the *infra-orbital plexus*. From the infra-orbital plexus branches ascend to the lower eyelid, other branches descend to the upper lip, and still others pass medially to the nose. After the branches of the infra-orbital plexus have been displayed clean the buccal branch of the facial nerve. Follow it through the pad of fat called the *suctorial pad* which lies on the buccinator muscle. Secure, if possible, its junction with the buccinator branch of the mandibular division of the trigeminal nerve, which issues from under cover of the middle of the anterior border of the masseter muscle, and follow its branches of supply to the buccinator muscle. It may be necessary to cut through the anterior border of the masseter to secure the buccinator branch of the mandibular nerve. Next detach the triangularis from the angle of the mouth and turn it downwards to its insertion, secure the twig it receives from the mandibular branch of the facial nerve, and display the union of that branch with the mental branch of the alveolar division of the trigeminal nerve, which issues through the mental foramen, under cover of the triangularis and below the second lower premolar tooth. Secure also a twig from the mandibular branch of the facial nerve which supplies the quadratus labii inferioris. Accompanying the mandibular nerve deep to the triangularis there is, usually, a definite branch of the external maxillary artery which used to be called the inferior labial. Finally, reflect the posterior part of the platysma below the mandible to display the cervical branch of the facial nerve, which issues from the lower part of the parotid gland to supply the platysma and to communicate with the upper branch of a cutaneous nerve called the nervus cutaneus colli. Do not follow it to its termination at present

(see p. 122). After the various structures mentioned have been cleaned proceed to the study of the anterior facial vein, the external maxillary artery, and the terminal branches of the facial nerve.

Vena Facialis Anterior (O.T. **Facial**).—The anterior facial vein is a less tortuous vessel than the external maxillary artery, to which it corresponds; and it lies posterior to the artery, and on a slightly more superficial plane (Fig. 15). It commences as the *angular vein*, which is formed at the medial commissure of the eyelids, by the union of the frontal and supra-orbital veins, which descend from the forehead. It passes downwards and backwards, in a comparatively straight line, to the anterior inferior angle of the masseter, which it crosses immediately behind the external maxillary artery; then it pierces the deep fascia of the neck, and enters the submaxillary triangle. In the upper part of the face it lies on the quadratus labii superioris; then it is situated between the zygomaticus and the risorius superficially and the buccinator deeply; and as it crosses the anterior angle of the masseter it is covered with the skin, superficial fascia, and the platysma.

Tributaries.—In addition to the frontal and supra-orbital veins, it receives external nasal, palpebral, superior labial, inferior labial, masseteric and superficial parotid tributaries. As it crosses the buccinator muscle it is joined by the *deep facial vein*, which connects it with the pterygoid plexus of veins in the infra-temporal region.

Arteria Maxillaris Externa (O.T. **Facial**).—The external maxillary artery is a tortuous vessel which enters the face at the lower and anterior angle of the masseter, after turning round the lower border of the mandible and piercing the deep fascia of the neck. From that point it runs forwards and upwards to the angle of the mouth, where it assumes a more vertical direction, and becomes the angular artery, which ascends, in the substance of the angular head of the quadratus labii superioris, to the medial commissure of the eyelids. Immediately after its entrance into the face it is comparatively superficial, being covered by skin, superficial fascia, and platysma, and it is easily compressed against the bone. More anteriorly it lies between the zygomaticus superficially and the buccinator deeply, then between the quadratus labii superioris and the caninus, which springs from the maxilla below the infra-orbital foramen. Its terminal part is usually embedded in the substance of the quadratus labii superioris (Figs. 4, 15).

Branches.—The branches of the external maxillary artery form two groups, a posterior and an anterior. The branches

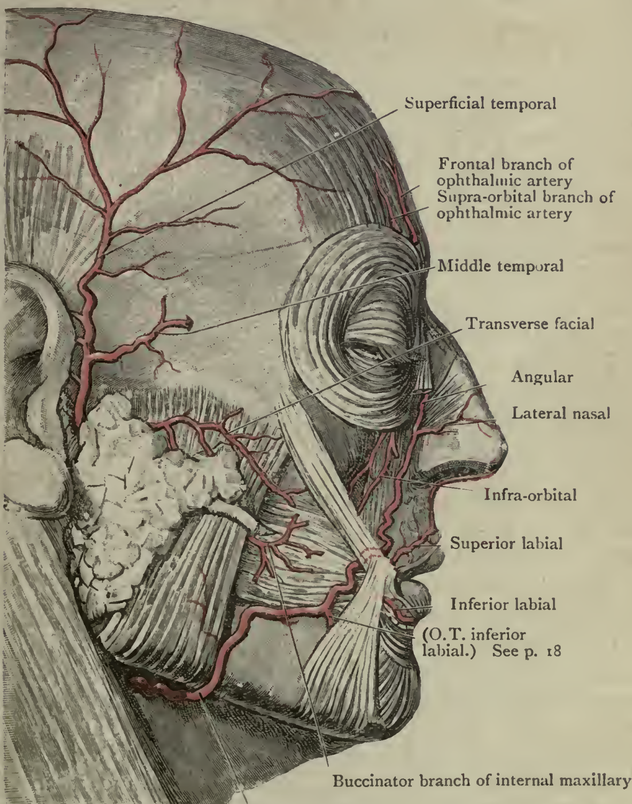


FIG. 4.—Arteries of the Face.

of the posterior group pass backwards and are of small size. They are distributed to the masseteric, buccal, and malar regions, where they anastomose with the transverse facial, the buccinator, and the infra-orbital arteries.

The branches of the anterior group, which run forwards, receive special names: they are the inferior labial, the superior labial, the lateral nasal, and the angular continuation.

The *inferior labial* (O.T. *inferior coronary*) arises below the level of the angle of the mouth and passes towards the median plane, under cover of the triangularis, the quadratus labii inferioris, and the orbicularis oris. In the substance of the lip it lies immediately adjacent to the mucous membrane, and it anastomoses, in the median plane, with its fellow of the opposite side.

The *superior labial* arises about the level of the angle of the mouth and runs medially in the upper lip, between the orbicularis oris and the mucous membrane. Before it anastomoses with its fellow of the opposite side, it gives off a branch, *the septal artery of the nose*, which passes upwards and ramifies on the lower and anterior part of the nasal septum, where it anastomoses with the septal branch of the spheno-palatine artery.

The *lateral nasal branch* springs from the external maxillary above the angle of the mouth. It ramifies on the side of the nose and anastomoses, in the median plane, with its fellow of the opposite side.

The *angular artery* is the continuation of the external maxillary beyond the point of origin of the lateral nasal branch. It runs upwards in the substance of the angular head of the quadratus labii superioris, and it terminates, at the medial commissure of the eye, by anastomosing with the dorsal nasal branch of the ophthalmic artery.

In addition to the branches already noted, a very definite branch is usually given off from the anterior aspect of the external maxillary artery immediately after it crosses the lower border of the mandible. This branch (O.T. inferior labial) runs towards the median plane under cover of the triangularis and the quadratus labii inferioris, and it anastomoses not only with the inferior labial (O.T. inferior coronary) above, and its fellow of the opposite side in the median plane, but also with the mental branch of the inferior alveolar artery.

The Terminal Branches of the Facial Nerve.—The dissector should note that there are five terminal branches, or groups of branches, of the facial nerve: (1) temporal; (2) zygomatic; (3) buccal; (4) mandibular; (5) cervical. They all emerge from under cover of the parotid gland, the temporal branches at its upper end, the cervical at its lower end, and the remaining three groups of branches at its anterior border (Fig. 5).

The *temporal branches* of the facial nerve cross the zygomatic arch and pass upwards and forwards towards the forehead; they supply twigs to the anterior and superior muscles of the auricle, to the upper fibres of the orbicularis

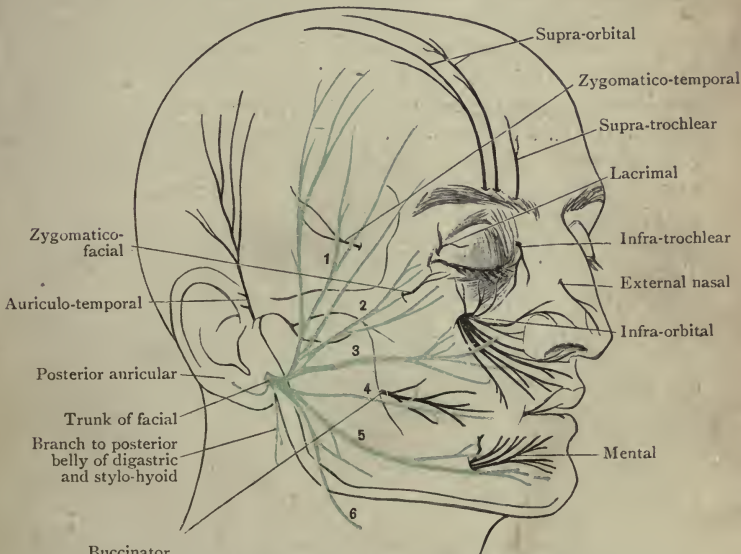


FIG. 5.—Nerves of the Face. The facial nerve is depicted in green, the sensory branches of the trigeminal in black.

1. Temporal branches.
2 and 3. Zygomatic branches.
4. Buccal branch.
5. Mandibular branch.
6. Cervical branch.

oculi and to the frontal belly of the epicranius. One of the branches communicates with the zygomatico-temporal branch of the trigeminal nerve, which pierces the temporal fascia behind the zygomatic bone.

The upper filaments of the *zygomatic branches* run forwards across the zygomatic bone, and terminate, in both the upper and the lower eyelid, in the fibres of the orbicularis oculi. If the branches are carefully traced, one of them will be found to communicate with the zygomatico-facial branch of the second or maxillary division of the trigeminal nerve.

That small nerve pierces the zygomatic bone a short distance below the lateral border of the orbit.

The lower filaments are larger. They run forwards along the lower border of the zygomatic arch, under cover of the musculus zygomaticus and the infra-orbital part of the quadratus labii superioris, and deep to the latter they communicate with the infra-orbital branch of the maxillary division of the trigeminal nerve, forming with it the *infra-orbital plexus.*

The *buccal branch or branches* run towards the angle of the mouth. At the anterior border of the masseter they communicate, around the anterior facial vein, with the buccinator branch (O.T. long buccal) of the third division of the trigeminal, and they supply the buccinator and the orbicularis oris.

The *mandibular branch or branches* run forwards along the mandible to be distributed to the muscles of the lower lip. They pass deep to the triangularis, and they communicate, under cover of it, with the mental branch of the inferior alveolar (O.T. dental) nerve.

The *cervical branch* after its exit from the lower end of the parotid gland runs downwards and forwards to supply the platysma and to communicate with the nervus cutaneus colli, but since neither the terminal branches nor the communication can be seen at present they will be displayed at a later stage of dissection (see p. 122).

Dissection.—After the branches of the facial nerve, the external maxillary artery and the anterior facial vein have been studied, the dissection of the deeper muscles and the deeper vessels and nerves must be proceeded with; but the supra-orbital and supra-trochlear nerves, and the supra-orbital vessels, may be left till the scalp is dissected (p. 47).

First clean the *caninus muscle* which lies deep to the infra-orbital plexus and descends to the angle of the mouth, where it blends with the orbicularis oris. Then clean the remains of the fat from the surface of the *buccinator*, and as the fat is being removed note the small *molar glands* which lie in it and the strong deep bucco-pharyngeal fascia which covers the muscle. The ducts of the molar glands pierce the bucco-pharyngeal fascia and the buccinator and open into the vestibule of the mouth. Clean away the bucco-pharyngeal fascia and define the attachments of the buccinator to the maxilla and the mandible, and trace its fibres forwards to the angle of the mouth, where they blend with the orbicularis oris.

Musculus Caninus (O.T. **Levator Anguli Oris**). — The caninus is concealed by the lower part of the orbicularis oculi, the quadratus labii superioris, and the zygomaticus, and it is crossed superficially, near the angle of the mouth, by the external maxillary artery. When the structures superficial to it are turned aside, the muscle will be found springing from the canine fossa below the infra-orbital foramen. It passes downwards to the angle of the mouth, where it blends with the orbicularis oris, some of its fibres passing into the lower lip (Fig. 3). It is an elevator of the angle of the mouth and is supplied by the facial nerve.

M. Buccinator.—The buccinator muscle occupies the interval between the maxilla and the mandible and forms a most important part of the substance of the cheek. Above, it springs from the alveolar border of the maxilla, in the region of the molar teeth. Below, it arises from the

FIG. 6.—Arrangement of the Fibres of the Buccinator Muscles at the Angles of the Mouth.

alveolar border of the mandible, also in the region of the molar teeth, and, posteriorly, it is attached to the pterygo-mandibular raphe, which forms a bond of union between the buccinator and the superior constrictor of the pharynx. The last-mentioned attachment will be seen to better advantage when the wall of the pharynx is studied (p. 286). Anteriorly, the fibres of the buccinator converge towards the angle of the mouth, where they blend with the orbicularis oris, of which they form a large part. The manner in which the fibres enter the orbicularis must be carefully noted. The upper and lower fibres pass directly to the corresponding lips; the middle fibres, on the other hand, decussate at the angle of the mouth, so that the lower fibres of the series enter the upper lip, whilst the higher fasciculi reach the lower lip (Fig. 3).

The buccinator muscle is not classified as a muscle of mastication, but it is used during mastication to prevent food accumulating between the cheeks and the teeth, the contractions of the muscle forcing the food back, between the teeth, into the cavity of the mouth proper. It is also used for blowing and whistling. It is supplied by the facial nerve.

The Molar Glands.—The pad of fat which covered the buccinator posteriorly, and which was removed, as the buccal branch of the mandibular nerve was cleaned, is known as the corpus adiposum buccæ, or *suctorial pad.* Its removal exposed the bucco-pharyngeal fascia and a number of small glands, called the *molar salivary glands.* The ducts of the molar glands pierce the buccinator and open into the vestibule of the mouth. One or two *buccal lymph glands* also are sometimes found resting on the superficial surface of the buccinator.

Dissection.—After the dissection of the buccinator and the molar glands is completed, remove the stitches from the lips; evert the lips and dissect the mucous membrane from the deep surfaces, in order to expose the muscular slips which attach the orbicularis oris to the alveolar margins of the maxilla and the mandible, and to display the mentalis muscle. As the lips are everted the dissector should note that a fold of mucous membrane, the *frenulum labii*, passes from each lip to the adjacent gum in the median plane; and as the mucous membrane is removed a number of small *labial salivary glands*, which lie in the submucous tissue, will be seen. They are readily felt in the living subject when the tip of the tongue is pressed against the inner surfaces of the lips.

Musculi Incisivi Labii Superioris et Inferioris.—The incisive muscles of the upper and lower lips are four small muscular bundles, two upper and two lower, which attach the deeper part of the orbicularis oris to the alveolar margins of the maxillæ and mandible in the regions of the upper and lower lateral incisor teeth.

Musculus Mentalis.—When the incisive muscles of the mandible are detached from the bone and the lower lip is further everted, a distinct muscular bundle will be found on each side, springing from the outer surface of the socket of the canine tooth, under cover of the quadratus labii inferioris. The two bundles converge and blend together, between the medial borders of the musculi quadrati labii inferioris, to form a single bundle which is inserted into the skin of the chin. It is an elevator of the skin of the chin. It is supplied by the facial nerve.

Nervus Buccinatorius (O.T. **Long Buccal**).—The buccinator nerve is a branch of the mandibular division of the trigeminal nerve. It passes forwards into the cheek from under cover of the ramus of the mandible. It is a sensory nerve, and it supplies branches to the skin on the outer surface, and the mucous membrane on the inner surface, of the buccinator muscle. Its communications with the buccal branch of the facial nerve has already been referred to (see p. 20).

Palpebræ.—In the eyelids the following strata will be exposed as the dissection is carried from the surface towards the conjunctiva.

Upper Lid.	Lower Lid.
1. Integument.	1. Integument.
2. Palpebral part of the orbicularis oculi.	2. Palpebral part of the orbicularis oculi.
3. The tarsus, the palpebral fascia, and the expanded tendon of the levator palpebræ superioris.	3. The tarsus and the palpebral fascia.
4. Conjunctiva.	4. Conjunctiva.

In addition to the structures enumerated in the above list, two ligamentous bands, named the medial palpebral ligament (O.T. internal tarsal ligament) and the lateral palpebral raphe (O.T. external tarsal ligament), will be noticed. They attach the tarsi to the medial and lateral margins of the orbit.

Integument and Orbicularis Oculi.—Both the skin and the orbicularis oculi have been examined already, and the skin has been reflected.

> ***Dissection.***—Separate the palpebral part of the orbicularis oculi from the remainder by a circular incision; turn the palpebral part towards the rima palpebrarum, and take care, whilst raising the muscle fibres, to preserve the palpebral vessels and nerves, and at the same time to avoid injury to the palpebral fascia. As the dissection is completed the origin of the muscle from the medial palpebral ligament (p. 7) will be displayed.

Tarsi.—The removal of the palpebral part of the orbicularis oculi brings into view the palpebral fascia and the tarsi. They lie in the same morphological plane, and they constitute the ground-work of the eyelids (Fig. 7).

The *tarsi* are two thin plates of condensed fibrous tissue, placed one in each eyelid so as to occupy an area immediately adjoining its free margin. They differ very materially from each other. The *superior tarsus* is much the larger of the two, and presents the figure of a half oval. Its deep surface is intimately connected with the subjacent conjunctiva, whilst its superficial surface is clothed by the orbicularis muscle, and is in relation to the roots of the eyelashes. Its superior border is thin, convex, and is continuous with a tendinous expansion of the levator palpebræ superioris, and with the palpebral fascia which attaches it to the margin of the orbit. The inferior border of the tarsus is thickened and straight, and the integument adheres firmly to it.

The *inferior tarsus* is a narrow strip which is similarly placed in the lower lid. It is connected with the inferior margin of the orbit by the inferior part of the palpebral fascia.

Glandulæ Tarsales (O.T. **Meibomian Follicles**).—At this stage the student should examine the tarsal glands, which he will display by everting the eyelids. They are placed on the deep surfaces of the tarsi. To the naked eye they appear as closely placed, parallel, yellow, granular-looking streaks, which run at right angles to the free margins of the lids. They are more numerous and of greater length in the upper lid, and, being lodged in furrows on the deep surface of the tarsi, they are distinctly visible upon both aspects of them, even while the conjunctiva is in position. Their ducts open upon the free margin of each lid, posterior to the eyelashes.

The Palpebral Fascia.—The palpebral fascia is a sheet of fibrous membrane which occupies the interval between the tarsi and the margins of the orbit, forming, with the tarsi, a septum between the orbit and the exterior. Its peripheral border is attached to the orbital margin, except at the medial angle of the orbit, where it occupies a more posterior plane, and is attached to the crista lacrimalis, posterior to the medial palpebral ligament and the lacrimal sac. Its central border in the lower lid is connected with the lower border of the lower tarsus. In the upper lid it blends with the expanded tendon of the levator palpebræ superioris, and is attached with it to the anterior surface of the upper tarsus. It is pierced by the supra-orbital, supra-trochlear, and lacrimal branches of the ophthalmic division of the trigeminal nerve, and by the terminal branches of the ophthalmic artery.

Raphe Palpebralis Lateralis.—The lateral palpebral raphe (O.T. external tarsal ligament) is merely a thickening of the palpebral fascia, between the lateral commissure and the medial border of the fronto-sphenoidal process of the zygomatic bone (O.T. malar), to which it connects both the tarsi.

Ligamentum Palpebrale Mediale (O.T. *Internal Tarsal Ligament*).—The medial palpebral ligament is a strong fibrous band which connects the medial ends of both tarsi to the frontal process of the maxilla. It lies between the skin

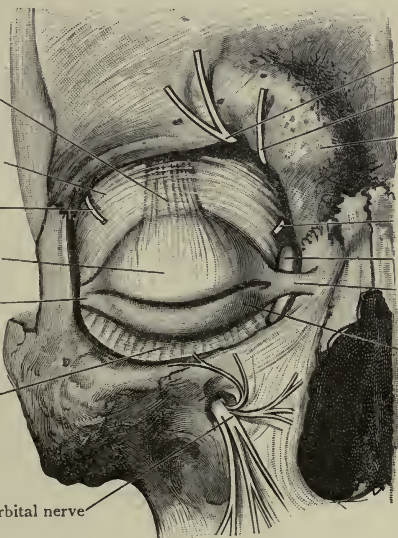


FIG. 7.—Dissection of the Right Eyelid. The orbicularis oculi has been completely removed.

anteriorly, and the lacrimal sac posteriorly. By its upper and lower borders it gives attachment to fibres of the orbicularis oculi, and, by the lateral part of its posterior surface, to the pars lacrimalis of the orbicularis oculi (O.T. tensor tarsi).

Levator Palpebræ Superioris.—Only the anterior expanded tendon of the elevator muscle of the upper eyelid can be seen at the present stage of the dissection, and that, as a rule, in only a partially satisfactory manner. The muscle arises within the orbital cavity, extends forwards to the upper eyelid, and ends in an expanded tendon which splits into three lamellæ: a superior lamella, which blends with the upper part of the palpebral fascia and is attached with it to the anterior surface of the upper tarsus; an intermediate lamella, which is connected with the upper border of the upper tarsus; and an inferior lamella, which gains insertion into the upper fornix of the conjunctiva. It raises the upper eyelid by pulling on the upper tarsus, and at the same time elevates the upper fornix of the conjunctiva. It is supplied by the oculo-motor nerve.

Vessels and Nerves of the Eyelids.—At the medial commissure two arteries, the *palpebral branches* of the ophthalmic,

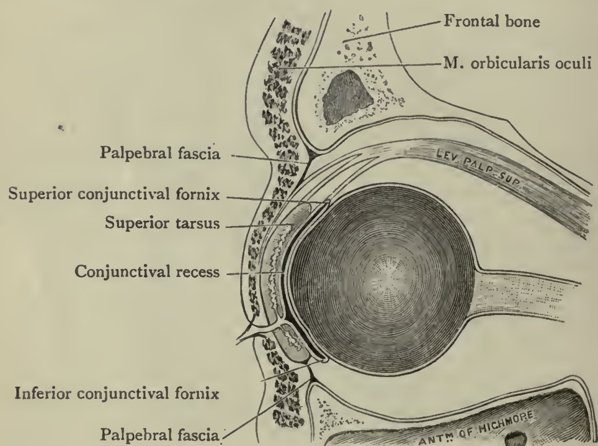


FIG. 8.—Diagram of the Structure of the Eyelids.

pierce the palpebral fascia and run laterally, one in the upper and one in the lower lid. At the lateral margin of the orbit, one or more branches of the lacrimal division of the ophthalmic pierce the palpebral fascia and anastomose with the palpebral branches of the ophthalmic. An arterial arch, *arcus tarseus*, is thus formed close to the margin of each eyelid, between the orbicularis muscle and the tarsus.

The veins run medially towards the root of the nose and open into the frontal and angular veins.

The nerves are more numerous and come from a number of different sources. The motor filaments for the various parts of the orbicularis oculi are derived from the temporal and zygomatic branches of the facial nerve. They enter from the lateral margins. The sensory twigs for the upper lid come from the lacrimal, supra-orbital, supra-trochlear, and infra-trochlear branches of the first or ophthalmic division of the trigeminal nerve; and the lower lid is supplied by the infra-orbital branch of the maxillary division of the fifth cerebral nerve. The lacrimal nerve will be found piercing the palpebral fascia near the lateral part of the upper border of the orbit; the supra-orbital lies in the supra-orbital notch at the junction of the lateral two-thirds with the medial third of the upper border; and the supra- and infra-trochlear pierce the palpebral fascia at the medial end of the upper border. The branches of the infra-orbital nerve pass to the lower lid in the palpebral branches of the infra-orbital plexus (p. 20).

Apparatus Lacrimalis.—The following structures are included under this head: (1) the lacrimal gland and its ducts; (2) the conjunctival sac; (3) the puncta lacrimalia; (4) the lacrimal ducts; (5) the lacrimal sac; (6) the naso-lacrimal duct; (7) the lacrimal part of the orbicularis oculi.

Glandula Lacrimalis.—The lacrimal gland lies in the upper and lateral part of the orbital cavity, under cover of the zygomatic process of the frontal bone. It can be exposed by cutting through the palpebral fascia at the upper and lateral angle of the orbit, and it will be found that the anterior part of the gland projects slightly beyond the orbital margin and rests upon the conjunctiva, as the latter is reflected from the lateral part of the upper lid on to the eyeball. If the anterior border of the gland is raised and the point of the knife is carried carefully up and down in the fascia under it, several exceedingly fine ducts will be found passing from the gland into the lateral part of the upper fornix of the conjunctiva (Fig. 9).

The ducts vary in number, and the secretion they convey, which constitutes the tears, is carried, by the involuntary movements of the upper eyelid, over the exposed surface of the eyeball and is directed towards the medial commissure; there it passes through the puncta lacrimalia into the lacrimal ducts, and is carried by them to the lacrimal sac, whence it passes by the naso-lacrimal duct into the inferior meatus of the nose. Under ordinary circumstances, the amount of lacrimal secretion is sufficient merely for lubrication, and practically the whole of it is evaporated from the surface of the eyeball; consequently, when the lacrimal ducts and the lacrimal sac are extirpated, a proceeding which is necessary under certain circumstances, the patient suffers little or no inconvenience from the overflow of tears, so long as the secretion is not excessive. If the amount of secretion

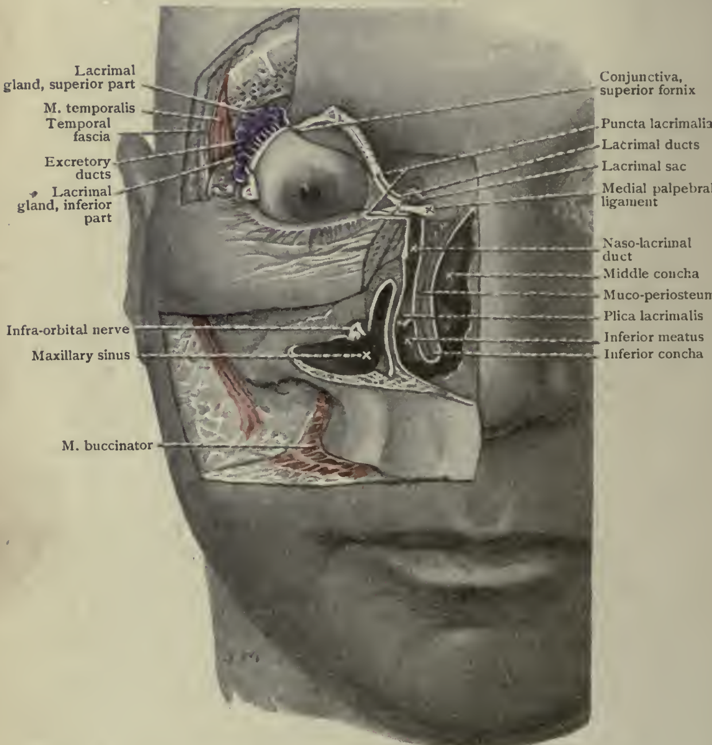


FIG. 9.—Dissection of Lacrimal Apparatus.

is greater than can be removed by evaporation, the excess, under ordinary circumstances, passes through the puncta into the ducts and thence through the lacrimal sac and naso-lacrimal duct to the inferior meatus of the nose. If the secretion becomes so abundant that it cannot be removed by evaporation and drainage, part flows through the rima as tears.

The Conjunctival Sac.—The cavity of the conjunctival sac is the potential space between the eyelids and the eyeball. It opens externally through the rima, and communicates with the lacrimal sac through the puncta and the lacrimal ducts.

Puncta Lacrimalia.—It has been noted already that the punctum lacrimale of each lid lies at the lateral margin of the lacus lacrimalis (p. 4). Small probes should now be passed through the puncta into the lacrimal ducts and along the ducts into the lacrimal sac (Fig. 9).

Saccus Lacrimalis.—The lacrimal sac is the blind upper end of a canal which extends from the orbit to the inferior meatus of the nose. It is lodged in the fossa lacrimalis in the anterior part of the medial wall of the orbit. It lies posterior to the medial palpebral ligament, from which it receives a fibrous expansion, and it is covered on its lateral aspect, and on the lateral part of its posterior aspect, by the pars lacrimalis of the orbicularis oculi. The lacrimal ducts open into its antero-lateral aspect, under cover of the medial palpebral ligament; and it is continuous below with the naso-lacrimal duct. The anterior wall of the sac should be incised and a probe should be passed down the naso-lacrimal duct into the inferior meatus of the nose. Note that as the probe passes along the duct it inclines downwards, laterally and slightly backwards.

Pars Lacrimalis M. Orbicularis Oculi (O.T. *Tensor Tarsi*).—The lacrimal part of the orbicularis oculi springs from the posterior aspect of the lateral part of the medial palpebral ligament and passes backwards and medially, round the lateral part of the lacrimal sac, to the crista lacrimalis of the lacrimal bone, to which it is attached. When it contracts it compresses the lacrimal sac, and so tends to facilitate the flow of the lacrimal secretion into the nose.

Ductus Naso-Lacrimalis.—The naso-lacrimal duct will be seen at a later period of the dissection. It lies in a bony canal in the lateral wall of the nose, and extends from the lacrimal sac to the upper and anterior part of the inferior meatus. It is about 12.5 mm. (half an inch) long, and its walls are composed of muco-periosteum. At the medial side of its lower end is a fold of mucous membrane, the *plica lacrimalis*, which serves as a flap valve (Fig. 9).

***Dissection.*—The dissection of the face should be completed by an examination of the nasal cartilages and the external nasal**

branch of the ophthalmic division of the trigeminal nerve. The nerve will be found emerging between the lower border of the nasal bone and the lateral cartilage of the nose. After its emergence it descends to the tip of the nose, supplying filaments to the skin. After it has been displayed, strip off the nasalis muscle and the remains of the integument and examine the cartilaginous part of the nose.

Cartilagines Nasi.—In addition to the septal cartilage, which will be more appropriately studied in the dissection of the nasal cavities, two cartilaginous plates will be found upon each side. They are :—

1. The lateral cartilage.
2. The cartilage of the ala.

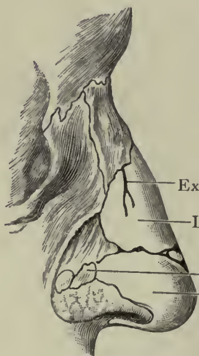


FIG. 10.—Cartilages of the Nose.

The *lateral cartilage* is triangular in form. Its posterior margin is attached to the lower border of the nasal bone and the upper part of the sharp margin of the nasal notch of the maxilla. The upper part of the medial border is continuous with the corresponding cartilage of the opposite side, and also with the subjacent anterior border of the septal cartilage of the nose; but the lower parts of the medial borders of the lateral cartilages are separated by a small interval in which the margin of the nasal septal cartilage is seen. The inferior border of the lateral cartilage is connected with the lateral part of the alar cartilage by fibrous tissue.

The *alar cartilage* is a bent plate which is folded round the anterior part of the nasal orifice. The *lateral part* is oval, and reaches neither down to the margin of the nostril, nor posteriorly as far as the nasal notch of the maxilla. The interval between it and the bone is filled in by fibrous tissue in which one or two small islands of cartilage (cartilagines minores vel sesamoideæ) appear. *Anteriorly*, the bent part of cartilage comes into contact with its neighbour and forms the point of the nose. The *medial part* of the cartilage is a narrow strip which lies against the lower part of the septal cartilage, and projects slightly below it, so as to support the margin of the nostril upon the medial side. Its posterior extremity is turned slightly laterally.

SIDE OF THE NECK.

On the fourth day after the body is brought into the room it is placed upon its back, and the dissectors of the head and neck should examine the side of the neck and commence the dissection of the posterior triangle.

The side of the neck is bounded *below* by the clavicle, *above* by the lower border of the mandible, the mastoid portion of the temporal bone, and the superior nuchal line of the occipital bone. *Anteriorly* it extends to the median plane, and *posteriorly* to the anterior border of the trapezius muscle. It is divided into anterior and posterior parts, the *anterior* and *posterior triangles*, by the sterno-mastoid muscle. If the head is pulled over towards the opposite side, the sterno-mastoid muscle will be seen descending from the mastoid portion of the temporal bone and the superior nuchal line of the occipital bone, to the upper border of the sternal third of the clavicle and the anterior surface of the manubrium sterni.

In the lower part of the posterior region, posterior to the sterno-mastoid and above the convex middle third of the clavicle, there is a depression called the *fossa supraclavicularis major*, to distinguish it from the *fossa supraclavicularis minor*, which lies between the sternal and clavicular heads of the sterno-mastoid, above the sternal end of the clavicle. The fossa supraclavicularis major overlies the brachial plexus, the third part of the subclavian artery, and the supra-clavicular lymph glands; and the fossa supraclavicularis minor indicates the position of the lower part of the internal jugular vein.

POSTERIOR TRIANGLE.

Dissection.—To expose the boundaries and contents of the posterior triangle make the following three incisions through the skin. (1) From the back of the auricle, along the upper border of the mastoid part of the temporal bone and the superior nuchal line to the external occipital protuberance. (2) From the sternal to the acromial end of the clavicle, following the line of that bone. (3) Join the anterior extremities of 1 and 2 by an incision, passing along the back of the external acoustic meatus, and then down the middle of the sterno-mastoid muscle. Reflect the flap, thus marked out, from before backwards, and note that the skin is thicker over the upper and posterior part of the triangle than over the lower and anterior part.

When the skin is reflected the superficial fascia and the lower part of the platysma muscle will be exposed.

The *superficial fascia* in the region of the posterior triangle is comparatively thin, and embedded in its lower and anterior part is the lower and posterior part of the platysma.

M. Platysma.—The platysma is a thin sheet of muscle which commences in the superficial fascia of the infra-clavicular region, whence it ascends, across the clavicle and through the superficial fascia of the side of the neck, to the face, where its upper border has been examined already (p. 7). It covers the lower and anterior part of the posterior triangle, and the upper and posterior part of the anterior triangle; and it is supplied by the cervical branch of the facial nerve, which emerges from the lower end of the parotid gland.

Dissection.—Make an incision through the lower part of the platysma along the line of the clavicle, and turn the part above the incision upwards and forwards. Whilst making the incision and whilst reflecting the muscle, be careful not to injure the supra-clavicular cutaneous nerves and the external jugular vein, which lie directly subjacent to the platysma.

After the platysma is reflected, clean the external jugular vein, which commences at the lower end of the parotid gland, and passes downwards, inclining backwards, to the lower and anterior angle of the posterior triangle, where it pierces the deep fascia. (See pp. 34, 40, and Figs. 11 and 15.) Whilst cleaning the vein, avoid injury to the nervus cutaneus colli, which sometimes crosses superficial to the vein about the middle of its length. Secure and clean the posterior auricular vein, which descends behind the auricle and joins the external jugular a little below the level of the angle of the mandible. Next, find and clean the superficial branches of the cervical plexus as they pierce the deep fascia. They are: (1) *Descending branches*, the anterior, middle, and posterior supra-clavicular nerves. (2) A *transverse branch*, the nervus cutaneus colli (O.T. transverse cervical). (3) *Ascending branches*, the great auricular and the lesser occipital (Figs. 11, 15).

The *anterior* and *middle supra-clavicular nerves* will be found piercing the deep fascia immediately above the clavicle, the anterior at the posterior border of the sterno-mastoid and the middle above the convexity of the clavicle. They descend into the pectoral region as far as the lower border of the second rib

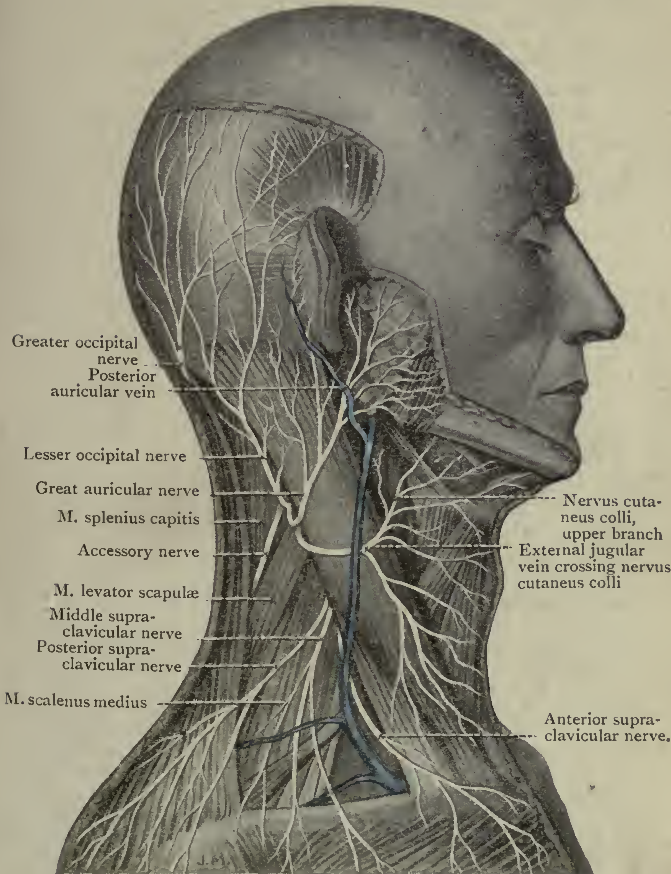


FIG. 11.—The superficial branches of the Cervical Plexus.

and their lower portions will be displayed by the dissector of the arm. The *posterior supra-clavicular nerves* pierce the deep fascia at a somewhat higher level. They descend across the lower and anterior part of the trapezius to the acromial region, and to the skin of the arm over the proximal part of the deltoid, where they will be exposed by the dissector of the arm (Fig. 11).

The *Deep Fascia.*—The deep fascia forms the superficial boundary or roof of the posterior triangle. It is attached, below, to the upper border of the middle third of the clavicle; above, to the superior nuchal line of the occipital bone; anteriorly, it is continuous with the fascia of the sterno-mastoid, and posteriorly, with the fascia of the trapezius. It is pierced by—(1) the supra-clavicular branches of the cervical plexus, (2) the external jugular vein, (3) small cutaneous branches of the transverse cervical, transverse scapular (O.T. suprascapular), and occipital arteries, and, occasionally, by the occipital artery itself. It is not a very strong layer, and it is frequently difficult to display it as a continuous sheet. Over the upper part of the triangle it forms a single layer, but below it splits into two lamellæ, a superficial and a deep. The superficial layer, which is already displayed, is attached to the upper border of the clavicle from the sterno-mastoid anteriorly to the trapezius posteriorly. It is pierced by the external jugular vein and the supraclavicular nerves.

Dissection.—Trace the supra-clavicular nerves upwards, through the deep fascia, to the posterior border of the sterno-mastoid; then, pulling them aside, cut through the superficial layer of the deep fascia immediately above the clavicle and along the posterior border of the sterno-mastoid, and turn it upwards. Introduce the handle of the scalpel behind the clavicle and note that it can be passed downwards as far as the posterior border of the lower surface of the bone. Its further progress is barred by the attachment of the second layer of the deep fascia to that border, where it blends with the posterior lamella of the costo-coracoid membrane. Pass the handle of the knife forwards deep to the sterno-mastoid, and note that, without using any great force, it can be pushed medially until it crosses the median plane; therefore, the space between the two layers of deep fascia in the lower part of the posterior triangle is continuous anteriorly with the space which lies above and posterior to the manubrium sterni, between the first and the second layers of the deep fascia of the anterior part of the neck. Laterally, that space extends as far as the coracoid process, and upwards to a short distance above the posterior belly of the omo-hyoid muscle, which lies a little above the clavicle. Take away the areolar tissue which lies between the two layers of the deep fascia, and expose a further part of the external jugular vein, and the terminal parts of the transverse cervical and the transverse scapular (suprascapular) veins, as they join the posterior border of the external jugular. Pull the lower part of the external jugular vein backwards and expose the termination of the anterior jugular vein in its anterior border. Dissect carefully behind the clavicle and find the transverse scapular (suprascapular) artery. Trace the second layer of the deep fascia upwards and note that it is continuous with the fascia which surrounds the posterior belly of the omo-hyoid muscle ; indeed, it is the tension of the second layer of the deep fascia which holds the posterior belly of the muscle down in its position (Fig. 51).

Remove the remaining parts of the deep fascia, first from the upper, and then from the lower part of the triangle, and expose the floor and the remaining contents of the triangle.

Commence above, in the region of the junction of the upper third and the lower two-thirds of the posterior border of the sterno-mastoid, and secure the great auricular, the lesser occipital and the accessory nerves, and the nervus cutaneus colli. The great auricular is most easily found. It turns round the posterior border of the sterno-mastoid, in the region indicated, and runs upwards and forwards, parallel with and slightly above and posterior to the external jugular vein. The lesser occipital will be found hooking round the lower border of the accessory nerve a little above the great auricular ; and the nervus cutaneus colli lies a little below the great auricular.

Follow the lesser occipital and the great auricular nerves to their terminations ; but the nervus cutaneus colli must be traced only to the point where it crosses either superficial or deep to the external jugular vein. It eventually divides into upper and lower terminal branches, which will be seen when the anterior triangle is dissected.

Nervus Occipitalis Minor.—The lesser occipital is a sensory branch of the second cervical nerve. It emerges from under cover of the sterno-mastoid, and ascends for a short distance along its posterior border; then it passes to the superficial surface of the muscle, pierces the deep fascia, and divides into occipital, mastoid, and auricular branches. The occipital and mastoid branches supply the skin in the regions indicated by their names. The auricular branch is distributed to the skin of the upper third of the cranial surface of the auricle.

Nervus Auricularis Magnus.—The great auricular nerve arises from the second and third cervical nerves. After turning round the posterior border of the sterno-mastoid, it runs upwards and forwards, on the superficial surface of the sterno-mastoid, towards the angle of the mandible. It breaks up into three sets of terminal cutaneous branches—mastoid, auricular, and facial. The *mastoid branches* go to the skin of the mastoid region. The *auricular branches* supply the skin of the lower two-thirds of the cranial surface and the lower third of the lateral surface of the auricle. The *facial branches*, which have already been seen, ramify in the posterior part of the face, in the parotid and masseteric regions. Some of the filaments enter the substance of the parotid gland.

Dissection.—The accessory nerve, previously found at the junction of the upper third with the lower two-thirds of the posterior border of the sterno-mastoid, must now be traced downwards and backwards, through the triangle, to the point where it disappears under cover of the trapezius, at the junction of the upper two-thirds with the lower third of the anterior border of that muscle. As the nerve is cleaned, attempt to secure twigs from the third and fourth cervical nerves which communicate with it in the posterior triangle.

Turn next to the posterior belly of the omo-hyoid muscle, which crosses the lower part of the triangle. Note that it divides the triangle into a large upper or occipital portion, and a small lower or subclavian portion. Cut through the fascia on the surface of the muscle, parallel with the muscle fibres, and turn it upwards and downwards ; then turn the upper border of the muscle laterally and find the nerve from the ansa hypoglossi which emerges from under cover of the sterno-mastoid and enters the deep surface of the posterior belly of the omo-hyoid to supply it.

Now remove any parts of the fascial roof of the upper part of the posterior triangle which are still present, and note a number of lymph glands which lie embedded in the subjacent areolar tissue ; they are placed along the posterior border of the sterno-mastoid, superficial to the stems and branches of the cervical nerves. At the apex of the triangle look for the occipital artery, which either emerges between the adjacent borders of the trapezius and the sterno-mastoid, or pierces the trapezius a little further back.

Between the accessory nerve above and the posterior belly of the omo-hyoid below find :—(1) the upper part of the brachial plexus ; (2) its branch to the subclavius ; (3) its suprascapular branch ; (4) its dorsalis scapulæ branch ; (5) its long thoracic branch ; (6) branches from the third and fourth cervical nerves to the levator scapulæ ; (7) branches from the third and fourth cervical nerves to the trapezius, and others which communicate with the accessory nerve in the posterior triangle ; and (8) the upper and posterior part of the transverse cervical artery. Find the transverse cervical artery as it appears from under cover of the upper border of the omo-hyoid. It runs upwards and backwards. Next, secure the nerve to the subclavius, which lies under cover of the deep fascia above the omo-hyoid immediately behind the sterno-mastoid. Trace it upwards to its origin from the trunk formed by the union of the fifth and sixth cervical nerves. Clean the latter nerves and the upper part of the seventh cervical nerve, which lies immediately below them. Then find the suprascapular nerve, which springs from the lateral border of the trunk formed by the fifth and sixth nerves. It lies immediately above the anterior part of the posterior belly of the omo-hyoid, and disappears under cover of the posterior part. Turn the trunk formed by the fifth and sixth cervical nerves forwards and find, posterior to it, the upper roots of the long thoracic nerve, which spring from the fifth and sixth nerves, and are emerging through the fibres of the scalenus medius muscle. The nervus dorsalis scapulæ (O.T. nerve to the rhomboids) lies at a slightly higher level than the suprascapular nerve. It springs from the fifth cervical nerve, runs downwards and backwards, and disappears, through the floor of the triangle, between the adjacent borders of the levator scapulæ above and the scalenus medius below. Above the dorsal scapular nerve are the branches from the third and fourth cervical nerves to the trapezius and the communications to the accessory nerve.

When the structures mentioned above have been found and cleaned, proceed to the dissection of the subclavian portion of the triangle. Find the transverse scapular artery which lies behind the clavicle, and therefore, strictly speaking, outside the limits of the triangle. Then remove the second layer of deep cervical fascia which binds the posterior belly of the omo-hyoid to the posterior border of the clavicle, and find behind it:—(1) a further part of the external jugular vein; (2) a further part of the transverse cervical artery; (3) the lower part of the nerve to the subclavius; (4) the upper portion of the third part of the subclavian artery; (5) the lowest root and the lower parts of the trunks of the brachial plexus; (6) a part of the long thoracic nerve; (7) inferior deep cervical lymph glands.

First clean the lower end of the external jugular vein and follow it behind the clavicle to its termination in the subclavian vein. Note the valves near its lower end. Next clean the transverse cervical artery and the nerve to the subclavius. Follow the nerve to the subclavius across the front of the third part of the subclavian artery; and afterwards clean the lower part of the subclavian artery and the adjacent part of the brachial plexus, which lies behind and above the artery. Note that the artery and the plexus are covered by a layer of deep cervical fascia, the backward prolongation of the prevertebral layer of fascia, which passes on to them from the lateral border of the scalenus anterior, which lies deep to the posterior border of the sterno-mastoid. The fascia is prolonged along the plexus and the artery to become continuous with the sheath of the axillary artery.

As the areolar tissue is cleared from the subclavian portion of the triangle a number of inferior deep cervical lymph glands may be noted. They receive lymph from the axillary glands, and they transmit it to the large lymph vessels at the root of the neck (Fig. 14, p. 29, Vol. I.).

After the contents of the lower part of the triangle are thoroughly cleaned, remove the remains of the fascia covering the muscles which form the floor of the triangle. Note that that fascia is continuous anteriorly, round the tips of the transverse processes of the cervical vertebræ, with the prevertebral fascia. Posteriorly, it blends with the sheaths of the deeper muscles at the back of the neck; above, it is attached to the superior nuchal line; and below, as already stated, it is prolonged into the axilla along the axillary vessels and nerves.

Boundaries and Contents of the Posterior Triangle.—The dissection of the triangle should be completed in two days. On the third day the dissector should revise his knowledge of the boundaries and the relative positions of the contents.

The triangle is bounded *anteriorly* by the posterior border of the sterno-mastoid; *posteriorly* by the anterior border of the trapezius; *below* by the upper border of the middle third of the clavicle; and *above* by the superior nuchal line of the occipital bone, or by the meeting of the upper ends of the sterno-mastoid and the trapezius. The *roof* is formed by the deep

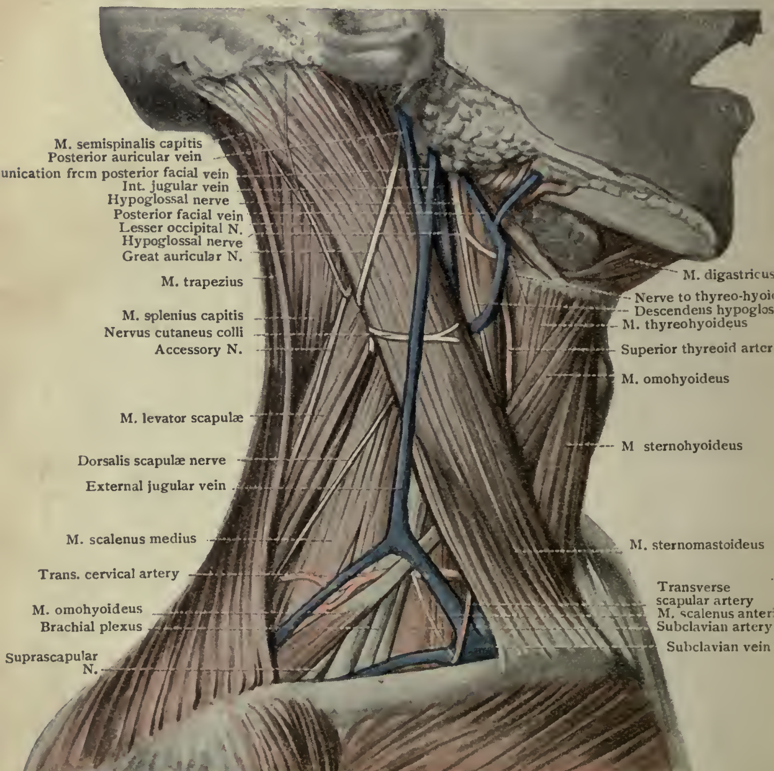


FIG. 12.—The Triangles of the Neck seen from the side. The clavicular head of the sterno-mastoid muscle was small, and therefore a considerable part of the scalenus anterior muscle is seen.

cervical fascia, which is covered by superficial fascia and skin, and in its lower and anterior part by the platysma, which is embedded in the superficial fascia. It is pierced by—(1) the external jugular vein, at the lower and anterior angle; (2) the supraclavicular nerves, a short distance above the clavicle; (3) small cutaneous branches of the transverse scapular, transverse cervical, and occipital arteries; (4) lymph vessels, passing from the superficial structures to the glands in the triangle. It is frequently stated that the lesser occipital and great auricular nerves and the nervus cutaneus colli also pierce the roof. As a general rule, they turn round the posterior border of the sterno-mastoid, under cover of the fascia, and pierce the fascia which lies on the sterno-mastoid muscle.

The *floor* is formed by the splenius capitis, the levator scapulæ, the scalenus medius, and the scalenus posterior muscles, with the addition, occasionally, of a small part of the semispinalis capitis (O.T. complexus), above, and the upper serration of the serratus anterior, below; the latter appears in the area of the triangle only when the clavicle is very fully depressed. The muscles of the floor are covered with a layer of fascia which is the backward continuation of the prevertebral fascia of the anterior cervical region.

The contents of the posterior triangle are:—

1. Fatty areolar tissue.
2. The posterior belly of the omo-hyoid muscle.
3. Lymph Glands,
   - Lateral superior deep cervical.
   - Inferior deep cervical (Supraclavicular).
4. Arteries,[1]
   - Third part of subclavian.
   - Transverse cervical and its terminal branches.
   - Occipital (sometimes).
5. Veins,[2]
   - External jugular.
   - Transverse cervical.
   - Transverse scapular (O.T. suprascapular).
   - Termination of anterior jugular.
6. Nerves,
   - Accessory.
   - Branches of cervical plexus.
     - Lesser occipital.
     - Great auricular.
     - Nervus cutaneus colli.
     - To levator scapulæ.
     - ,, trapezius.
     - ,, scalenus medius.
     - ,, ,, posterior.
     - Supraclavicular.
   - To posterior belly of omo-hyoid, from ansa hypoglossi.
   - Trunks of brachial plexus.
   - Branches of the brachial plexus.
     - The nervus dorsalis scapulæ.
     - ,, long thoracic.
     - ,, suprascapular.
     - ,, nerve to the subclavius.

---

[1] The transverse scapular artery (O.T. suprascapular) lies posterior to the clavicle and is not, strictly speaking, in the triangle.

[2] The subclavian vein is posterior to the clavicle and therefore is not contained within the triangle.

Some of the contents of the triangle which are now displayed require further consideration.

Vena Jugularis Externa.—The external jugular vein is superficial except in the terminal part of its extent.

It commences on the surface of the sterno-mastoid, below the lower end of the parotid gland, by the union of the posterior auricular vein with a branch from the posterior facial vein. After its formation it runs downwards and backwards, across the sterno-mastoid, to the upper and anterior angle of the supraclavicular portion of the posterior triangle, in which it pierces first the superficial layer and then the second layer of the deep fascia, and it terminates in the subclavian vein (Figs. 12, 15).

As it crosses the sterno-mastoid it lies at first parallel with but anterior to the trunk of the great auricular nerve, then deep to the platysma, and whilst beneath the platysma it crosses either superficial or deep to the nervus cutaneus colli (Fig. 12). At the posterior border of the sterno-mastoid it sometimes receives a vein called the *posterior external jugular vein*, which descends across the upper part of the posterior triangle from the occipital region. Between the two layers of the deep fascia of the supraclavicular triangle it receives the transverse cervical, the transverse scapular and the anterior jugular veins, and it lies superficial to the lower roots of the brachial plexus; as it pierces the second layer of deep fascia, it lies superficial to the third part of the subclavian artery.

Immediately above its termination it is provided with a valve, consisting of two or three semilunar cusps. The dissector should note that, as the vein pierces the deep fascia, its wall is closely connected with the margin of the opening through which it passes; consequently when the fascia is stretched the lumen of the vein is expanded.

The Posterior Belly of the Omo-hyoid Muscle.—The posterior belly of the omo-hyoid muscle springs from the upper border of the scapula and upper transverse scapular ligament. It enters the posterior triangle, at its lower and posterior angle; runs upwards and forwards, at a variable distance from the clavicle, to the posterior border of the sterno-mastoid, and divides the posterior triangle into occipital and subclavian or supraclavicular portions. Either immediately behind or under cover of the posterior border of the sterno-mastoid it joins the intermediate tendon which connects it with the anterior belly. Its nerve has already been seen entering its deep surface (p. 36). As it crosses the posterior triangle it lies superficial to the suprascapular nerve, the transverse cervical artery and the brachial plexus.

Nervus Accessorius (O.T. **Spinal Accessory**).—The portion of the accessory nerve which appears in the posterior triangle consists of fibres which arise from the cervical part of the spinal medulla, and with them are incorporated some filaments derived from the second cervical nerve. Before appearing in their present situation the spinal fibres entered the cranium through the foramen magnum and left it by passing through the jugular foramen; then they passed downwards and backwards, through the deeper fibres of sterno-mastoid, where they received the communication from the second cervical nerve. As already pointed out, the nerve usually enters the posterior triangle at the level of the union of the upper third with the lower two-thirds of the posterior border of the sterno-mastoid or at a slightly lower level. It runs downwards and backwards, through the triangle, along the line of the levator scapulæ, and disappears under the trapezius at the junction of the upper two-thirds with the lower third of its anterior border. As it enters the triangle the lesser occipital nerve turns round its lower border; and, as it crosses the triangle, it is joined by twigs from the third and fourth cervical nerves. It lies parallel with, but at a higher level than, the dorsalis scapulæ nerve (Fig. 12).

The Branches of the Cervical Plexus.—The dissector should note that whilst many of the branches of the cervical plexus lie within the area of the posterior triangle, the plexus itself is under cover of the upper part of the sterno-mastoid, where it will be exposed and studied when the sterno-mastoid is reflected. The branches which appear in the triangle are the *superficial branches*—(1) the lesser occipital; (2) the great auricular; (3) the nervus cutaneus colli, and (4) the supraclavicular nerves; and the *deep posterior branches*, that is, the nerves to (1) the scalenus medius and (2) the scalenus posterior; (3) the nerve to the levator scapulæ; (4) the branches to the trapezius, and (5) the communications to the accessory nerve.

The Third Part of the Subclavian Artery.—Only a portion of the third part of the subclavian artery is the triangle; the lower and lateral part is behind the clavicle. The part in the triangle is situated deeply in the anterior inferior angle, and below the omo-hyoid muscle. It lies *deep to* the skin, superficial fascia, the platysma, deep fascia, the external jugular vein, the ends of the transverse scapular and transverse cervical veins, and the nerve to the subclavius muscle. The lowest trunk of the brachial plexus is *behind* it and separates it from the insertion of the scalenus medius. *Below*, it rests upon the first rib, against which it can be compressed, and, more medially, upon the cervical pleura.

The Brachial Plexus and its Supraclavicular Branches.—Only the upper portion of the brachial plexus lies in the region of the posterior triangle, *i.e.* the roots, the trunks, and some of the branches; the remainder lies either posterior to the clavicle or in the axilla. The cervical portion lies in the lower and anterior part of the posterior triangle, partly in the occipital and partly in the supraclavicular areas. The detailed study of the plexus should be left till the fifth day after the body has been placed upon its back, when the dissector of the head and neck will assist the dissector of the upper extremity to disarticulate the clavicle and to lay bare the whole of the plexus (p. 36); but it should be noted now—(1) that the cervical part of the plexus lies deep to the skin, superficial fascia, platysma and deep fascia, and that it is crossed superficially by the posterior belly of the omo-hyoid muscle, the external jugular vein, the transverse cervical artery and the transverse cervical and transverse scapular veins; (2) that part of the third portion of the subclavian artery is superficial to the lower part of the plexus; and (3) that behind the plexus is the lower part of the scalenus medius muscle.

The fourth day after the body has been placed upon its back should be devoted to the study of the temporal region and the scalp.

THE SCALP AND THE SUPERFICIAL STRUCTURES OF THE TEMPORAL REGION.

Under the term "scalp" are included the soft structures which cover the vault of the cranium above the temporal lines and anterior to the superior nuchal line. Its constituent parts are arranged in five layers: (1) skin; (2) superficial fascia; (3) the epicranius, consisting of four muscular bellies, the two occipitales and the two frontales muscles, and the aponeurosis called the galea aponeurotica, which connects them together; (4) a layer of loose areolar tissue; (5) the periosteum, which in the region of cranium is called the pericranium. In the temporal region the wall of the cranium is much more thickly covered than in the scalp area, and it is possible to distinguish seven layers of soft tissues between the surface and the bone: (1) skin; (2) superficial fascia; (3) extrinsic muscles of the ear; (4) the thin lateral extensions

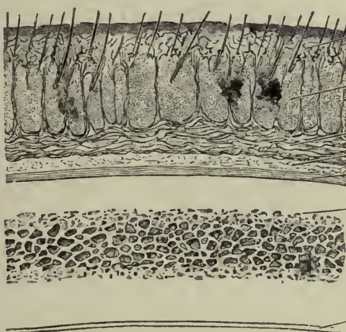


FIG. 13.—Section through the Scalp and Cranial Wall.

of the galea aponeurotica; (5) the strong temporal fascia; (6) the temporal muscle; (7) periosteum.

The Scalp.—The scalp and the superficial temporal region are richly supplied with blood vessels and nerves, which all enter from the periphery, passing into the superficial fascia after piercing the deep fascia of adjacent regions. As a consequence of that arrangement large flaps of the scalp may be torn from the centre towards the margin, but, so long as they remain attached at the periphery, their sources of vitality are not seriously interfered with, and, if they are cleaned and replaced, healing occurs rapidly and satisfactorily.

Dissection.—The skin has already been removed from the anterior parts of the scalp and the temporal region. A median longitudinal incision must now be made through the skin of the posterior part of the scalp as far as the external occipital protuberance, and the flap on each side of the incision must be turned downwards and backwards to the superior nuchal line. When that has been done the dissector should examine the auricle of the external ear, and familiarise himself with its various parts before he commences the dissection of its extrinsic muscles.

Auricula.—The auricle consists of a thin plate of yellow fibro-cartilage, covered with integument. It is fixed in position by certain ligaments, and possesses two sets of feeble muscles—viz., one group termed the *extrinsic muscles*, passing to the cartilage from the aponeurosis of the epicranius and the mastoid process, and a second group in connection with the cartilage alone, and therefore called the *intrinsic muscles.*

The wide and deep depression which leads into the external acoustic meatus is the *concha.* The ridge behind

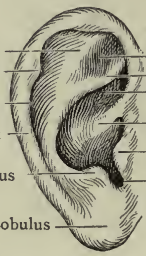


FIG. 14.—The Auricle.

the concha is the *antihelix.* It commences below, in a prominence called the *antitragus.* From the antitragus it curves upwards behind the concha, and it divides above into two crura which enclose a small depression called the *fossa triangularis.* Below the antitragus is the *lobule*, which forms the soft inferior extremity of the auricle. Its posterior border is continuous with the *helix*, which forms the incurved margin of the auricle. The helix ascends from the lobule to the summit of the auricle; then it descends, forming the anterior border of the upper part of the auricle, and, finally, it turns downwards and backwards above the external meatus, into the concha, which it partly divides into upper and lower portions. The part of the helix attached to the lobule is the tail of the helix (*cauda helicis*) and the part which passes from the anterior border of the auricle to the floor of the concha is the *crus helicis.* The depression which lies between the helix and the antihelix is the scaphoid fossa or fossa of the helix. At the point where the posterior border of the auricle turns forwards towards the superior extremity there is, sometimes, a small triangular prominence which is known as *Darwin's Tubercle.* It represents the apex of the ear of an ordinary quadruped. In front of the meatus, and extending backwards to overshadow it, is a triangular prominence called the *tragus.* It is separated from the antitragus by a notch known as the intertragic notch (*incisura intertragica*). Numerous hairs grow from the posterior surface of the tragus. They become very prominent in the male after the middle period of life.

The ligaments and muscles connected with the auricle are :—

Ligaments, ...	Anterior.	
	Superior.	
	Posterior.	
Extrinsic muscles,	Auricularis anterior.	
	Auricularis superior.	
	Auricularis posterior.	
Intrinsic muscles,	Musculus helicis major.	Upon the lateral face of the cartilage.
	Musculus helicis minor.	
	Musculus tragicus.	
	Musculus antitragicus.	
	Musculus transversus.	Upon the cranial face of the cartilage.
	Musculus obliquus.	

Dissection.—After the dissector has noted the various parts of the auricle he should endeavour to display its extrinsic muscles ; they are the *auriculares anterior* (O.T. *attrahens*), *superior* (O.T. *attollens*), and *posterior* (O.T. *retrahens*).

The auricularis anterior has already been dissected (see p. 14). It passes from the deep fascia of the temporal region to the front of the helix. To display the auricularis superior pull the upper part of the auricle downwards and carefully remove the superficial fascia above it. The muscle fibres spring from the lateral part of the galea aponeurotica and converge, as they descend, to the medial surface of the auricle in the region of the floor of the triangular fossa. After the auricularis superior has been cleaned pull the auricle forwards and clean the auricularis posterior. It is a thicker and more definite muscular bundle which springs from the mastoid portion of the temporal bone, above the mastoid process, and passes to the convexity on the medial surface of the auricle which corresponds with the floor of the concha. As the muscle is being cleaned one or more small *mastoid lymph glands* may be seen, and care must be taken to avoid injury to the branch from the posterior auricular nerve to the occipitalis part of the epicranius. It passes backwards either along the lower border of the auricularis posterior or under cover of that muscle.

The auriculares muscles are supplied by the facial nerve ; the anterior and the anterior part of the superior by its temporal

branches, and the posterior and the posterior part of the superior by the posterior auricular branch. After the auriculares muscles have been defined remove the skin from the entire extent of the auricle to display the cartilage, the ligaments, and the intrinsic muscles.[1] Great care is required to make a successful dissection.

The **auricular cartilage** extends throughout the entire auricle, with the exception of the lobule and the portion between the tragus and the helix. Those portions are composed merely of integument, fatty tissue, and condensed connective tissue. The shape of the cartilage corresponds with that of the auricle itself. It shows the same elevations and depressions, and by its elasticity it serves to maintain the form of the auricle. But it also enters into the formation of the cartilaginous or lateral portion of the external acoustic meatus. By its medial margin this part of the cartilage is firmly fixed by fibrous tissue to the rough lateral edge of the auditory process of the temporal bone, but it does not form a complete tube. It is deficient above and anteriorly, and there the tube of the meatus is completed by tough fibrous membrane, which stretches between the tragus and the commencement of the helix.

In a successful dissection of the cartilage of the auricle, two other points will attract the attention of the student. The first is a deep slit, which passes upwards so as to separate the lower part of the cartilage of the helix, termed the *processus helicis caudatus*, from the cartilage of the antitragus. The second is a sharp spur of cartilage which projects forwards from the helix, at the level of the upper margin of the zygoma; it is termed the *spina helicis*.

The Ligaments of the Auricle.—The ligaments are three bands of fascia. The anterior passes from the spine of the helix to the root of the zygoma. The superior and posterior are both attached to the cartilage in the region of the concha; the former blends above with the temporal fascia, and the latter is attached to the mastoid portion of the temporal bone.

The Intrinsic Muscles of the Auricle.—The two muscles of the helix, and the tragicus and the antitragicus, are placed upon the lateral face of the cartilage. The transversus and the obliquus lie upon the cranial surface of the auricle.

The *musculus antitragicus* is the best-marked member of the lateral group. It lies upon the lateral surface of the antitragus, and its fibres pass obliquely upwards and backwards. Some fasciculi can be traced to the processus helicis caudatus.

The *musculus tragicus* is a minute bundle of short vertical fibres situated upon the lateral surface of the tragus. When well developed a slender fasciculus may sometimes be observed to pass upwards from it to the anterior part of the helix, where it is inserted into the spine of the helix.

The *musculus helicis major* is a well-marked band, which springs from the spina helicis, and extends upwards upon the anterior part of the helix, to be inserted into the skin which covers it.

The *musculus helicis minor* is a minute bundle of fleshy fibres which is placed upon the crus helicis as it crosses the bottom of the concha.

The *musculus transversus auriculæ* is found upon the cranial aspect of the auricle. It is generally the most strongly developed muscle of the series, and its fibres bridge across the hollow which, on this aspect of the auricle, corresponds to the antihelix.

---

[1] In most cases it will be advisable to defer this part of the dissection till the body is turned on its back for the second time, and to proceed at once to the dissection described on p. 47.

The *musculus obliquus auriculæ* is composed of some vertical fasciculi bridging across the depression which corresponds to the eminence of the lower limb of the antihelix.

Dissection.—After the auricle and its muscles and ligaments have been dissected and studied, follow the superficial temporal vessels and the auriculo-temporal nerve upwards from the point where they emerge from the upper end of the parotid gland to their terminal distribution in the scalp. Next, pull the auricle forwards and trace the posterior auricular nerve to its termination in the occipitalis muscle, and in the intrinsic and extrinsic muscles of the auricle, and the posterior auricular artery to its anastomoses with the occipital and superficial temporal arteries. After that part of the dissection is completed, turn to the anterior part of the scalp and find the medial and lateral branches of the supra-orbital nerve. The medial branch pierces the fibres of the frontalis and the lateral branch pierces the galea aponeurotica a little further back. Trace both branches backwards, through the superficial fascia, as far as possible; they extend to the level of the lambdoid suture. Then secure the supra-trochlear nerve, which pierces the frontalis above the medial margin of the orbit, and trace it upwards to its termination. With the branches of the supra-orbital nerve are branches of the supra-orbital artery, and the supra-trochlear nerve is accompanied by the frontal branch of the ophthalmic artery.

When the nerves and vessels in the anterior region have been cleaned, the head should be turned well over to the opposite side, and the branches of the occipital artery and the greater occipital nerve should be sought for in the posterior region; they radiate upwards and forwards from the upper extremity of the trapezius. After they have been secured, the occipitalis muscle must be cleaned. It springs from the lateral part of the superior nuchal line, and after a short course upwards and forwards, it terminates in the galea aponeurotica. The remains of the superficial fascia should now be removed from the surface of the galea aponeurotica (O.T. epicranial aponeurosis), and then the dissector should make a survey of the vessels and nerves which are met with in the scalp and in the superficial fascia of the temporal region.

Nerves and Vessels of the Scalp and of the Superficial Temporal Region.—Branches of ten nerves are found, on each side, in the superficial fascia of the region which lies above the supra-orbital margin, the zygomatic arch and the superior nuchal line. Five of the ten lie mainly anterior to the auricle and five posterior to it; and of each group four are sensory and one is motor. The four sensory nerves anterior to the auricle are all branches of the trigeminal nerve. They are the *supra-trochlear* and *supra-orbital* branches of the *first* or *ophthalmic division*; the *zygomatico-temporal branch* of the *maxillary* or *second division*; and the *auriculo-temporal branch* of the *mandibular* or *third division*. The motor nerve is the *temporal branch* of the *facial nerve.*

The four sensory nerves distributed mainly to the scalp area behind the auricle are the *great auricular* and the *lesser occipital* branches of the cervical plexus; the *greater occipital*, which is the medial division of the posterior ramus of the second cervical nerve; and the *third occipital*, not yet seen, but which will be displayed when the body is turned on its face. It lies medial to the greater occipital, and is the medial division of the posterior ramus of the third cervical nerve. The motor nerve distributed posterior to the auricle is the *posterior auricular branch* of the facial nerve.

The *arteries* distributed to the scalp are five in number on each side; they anastomose freely, and are derived, either indirectly or directly, from the internal and external carotid arteries. Three are distributed mainly anterior to, and two posterior to the region of the auricle. The three anterior to the auricle are the *frontal* and *supra-orbital branches* of the ophthalmic branch of the internal carotid, which accompany the supra-trochlear and supra-orbital nerves, respectively, and the *superficial temporal branch* of the external carotid. The superficial temporary artery divides into two main divisions, an anterior division, which accompanies the temporal branches of the facial nerve, and is usually a very tortuous vessel, and a posterior division, which accompanies the auriculo-temporal nerve, as it ascends, anterior to the auricle, towards the vertex of the cranium. The two arteries posterior to the auricle are both branches of the external carotid. They are the *posterior auricular*, which accompanies the posterior auricular branch of the facial nerve to the mastoid region and the posterior part of the parietal region, and *the occipital*, which is distributed to the occipital area and posterior part of the parietal area (Figs. 15, 17, 51).

The *terminations of the veins* which drain the blood from the scalp are as follows. The *frontal* and *supra-orbital veins* unite, at the medial border of the orbit, to form the *angular vein*, which is the commencement of the anterior facial vein, already dissected (p. 16). The blood it conveys passes eventually to the internal jugular vein. The *superficial temporal vein* accompanies the corresponding artery. It unites, immediately above the posterior root of the zygoma, with the middle temporal vein, which pierces the temporal fascia at that point. The trunk formed by the union of the superficial and middle temporal veins is the *posterior facial vein*, which

PLATE I

FIG. 15.

PLATE I

FIG. 15.—Dissection of the Head and Neck.

The sterno-mastoid muscle is left in position, the intermediate third or the clavicle has been removed and the medial part of the subclavius muscle has been turned downwards. Parts of the anterior, posterior and common facial veins have been removed.

1. Supra-orbital artery and nerve.
2. Frontal artery and vein.
3. Lateral nasal branch of external maxillary artery.
4. Superior labial branch of external maxillary artery.
5. Inferior labial branch of external maxillary artery.
6. Anterior facial vein.
7. External maxillary artery.
8. Cervical branch of facial nerve communicating with N. cutaneus colli.
9. External carotid artery.
10. Common facial vein.
11. Superior thyreoid artery.
12. Anterior jugular veins.
13. Omo-hyoid muscle (anterior belly).
14. External jugular vein.
15. Transverse cervical vein.
16. Sterno-mastoid muscle.
17. Subclavian artery.
18. Subclavius muscle with nerve.
19. Cephalic vein.
20. Lateral anterior thoracic nerve.
21. Axillary vein.
22. Acromial branch of thoraco-acromial artery.
23. Transverse scapular vessels.
24. First serration of serratus anterior muscle.
25. Omo-hyoid muscle (posterior belly).
26. Supra-scapular nerve.
27. Transverse cervical artery on scalenus medius muscle.
28. Upper root of long thoracic nerve.
29. Trapezius.
30. Ascending branch of transverse cervical artery which arose separately from the thyreo-cervical trunk.
31. Accessory nerve.
32. Levator scapulæ muscle.
33. Internal carotid artery.
34. Great auricular nerve.
35. Commencement of external jugular vein.
36. Lesser occipital nerve.
37. Third occipital nerve.
38. Greater occipital nerve and occipital artery.
39. Parotid gland.
40. Transverse facial vessels.
41. Posterior auricular vein.
42. Superficial temporal vessels and auriculo-temporal nerve.

descends through the parotid gland, emerges from under cover of its lower end and terminates, immediately below the angle of the mandible, by joining with the anterior facial vein to form the common facial vein. Whilst in the gland, it gives off a branch to the external jugular vein. The *posterior auricular vein* descends posterior to the external meatus and terminates in the external jugular vein. The *occipital vein* accompanies the occipital artery as far as the sub-occipital region, and ends in the sub-occipital venous plexus.

In addition to the arteries and veins there are numerous *lymph vessels* in the scalp, but they cannot be displayed by ordinary dissecting methods. Nevertheless, it is important that the student should remember their usual terminations. The lymph vessels of the anterior area end in small lymph glands which are embedded in the superficial surface of the parotid gland. Those of the posterior area terminate either in lymph glands which lie superficial to the mastoid part of the temporal bone, or in occipital lymph glands, which lie in the neighbourhood of the superior nuchal line.

Galea Aponeurotica (O.T. **Epicranial Aponeurosis**).—The galea aponeurotica is fully exposed as soon as the superficial fascia of the scalp is completely removed. It is a strong layer of aponeurosis connected anteriorly with the frontal bellies of the epicranius, posteriorly with the occipital bellies, and between the occipital bellies, with the external occipital protuberance and the medial parts of the superior nuchal lines, or with the supreme nuchal lines when they are present. Laterally, where it becomes thinner, it descends over the upper part of the temporal fascia, and gives origin to the anterior and superior auriculares muscles. It is so closely connected with the superjacent skin, by the dense superficial fascia, that the two cannot be separated, except with the aid of the cutting edge of the scalpel; but above the supra-orbital ridges, the temporal lines, and the superior nuchal lines it is only loosely connected to the pericranium by the layer of loose areolar tissue; therefore the three closely connected superficial layers, the skin, superficial fascia, and the galea aponeurotica, can easily be torn from the pericranium, a circumstance taken advantage of by the Indians who scalped their defeated foes. The looseness of the areolar tissue beneath the galea aponeurotica permits the latter to be drawn forwards and backwards by the alternate contractions of the occipitalis and frontalis muscles, and, as it moves, it carries with it the skin and superficial fascia with which it is so closely blended.

Dissection.—After the dissector has studied the attachments of the galea aponeurotica, and after he has made himself thoroughly conversant with the nerve and vascular supply of the scalp, and has appreciated the fact that every part of its area is supplied by more than one nerve and that the blood vessels anastomose very freely together, he should next convince himself of the greater looseness of the areolar layer beneath the galea in the medial area and its greater denseness and closer attachment to the various parts of the superjacent epicranius, and the subjacent pericranium at the margins of the scalp area. He may do that by introducing the handle of a scalpel through a median incision in the galea, and passing it forwards and backwards and from side to side.

The Layer of Loose Areolar Tissue.—The layer of loose areolar tissue is the fourth layer of the scalp. It is but slightly vascular and is of loose texture, but is not equally loose over the whole area of the scalp; on the contrary, in the regions of the temporal and supra-orbital ridges it becomes much denser, and, at the same time, much more closely connected with the galea aponeurotica and the frontalis muscles, whilst posteriorly it disappears where the occipitalis muscles and the galea become attached to the superior nuchal lines. It is on account of those peculiarities that effusions of blood of inflammatory exudations in the areolar layer easily raise the greater part of the scalp from the bone, but such effusions do not readily pass from beneath the scalp into either the facial, temporal, or occipital regions.

On the fifth day after the body has been placed upon its back, the eighth after it was brought into the room, the dissector of the head and neck must assist the dissector of the upper extremity to display the whole extent of the brachial plexus and the origins of the branches which spring from it; and he should take the opportunity to revise his own knowledge of the plexus.

Dissection.—Detach the clavicular head of the sterno-mastoid from the clavicle, and displace the sternal head towards the median plane. When that has been done the anterior and upper parts of the sterno-clavicular joint capsule will be fully exposed, for the pectoralis major, which covered the lower part of the anterior surface, has already been reflected by the dissector of the upper extremity.

The sterno-clavicular joint is described on p. 37 of Vol. I. After the dissectors have noted that the fibres of the capsule run

medially and downwards from the clavicle to the sternum, the anterior, superior, and posterior portions must be divided close to the sternum, care being taken to avoid injury to the anterior jugular vein, which passes laterally close to the upper and posterior part of the joint. When the division is completed, elevate the sternal end of the clavicle by depressing the acromial end; introduce the knife into the cavity of the joint, close to the sternum, and carry it laterally below the clavicle, to detach the lower part of the articular disc from the sternum and the cartilage of the first rib, and to divide the lower part of the capsule and the costo-clavicular ligament, which lies immediately lateral to it. If the subclavius muscle has not already been detached, it also must be divided, and then the clavicle can be displaced laterally, and the whole extent of the plexus will be exposed.

Plexus Brachialis.—The brachial plexus is fully described on p. 39, Vol. I., and only a brief résumé of the main facts regarding it is given here. The plexus is formed by the last four cervical nerves and the larger part of the first thoracic nerve; it also receives a communication from the fourth cervical nerve and not uncommonly a small twig from the second thoracic nerve. Those various nerves constitute the *roots of the plexus*. The roots of the plexus emerge from between the scalenus medius and the scalenus anterior, and unite to form *three trunks*, upper, middle, and lower, which lie superficial to the scalenus medius, the lowest of the three being wedged in between that muscle posteriorly and the third part of the subclavian artery anteriorly. The *upper trunk* is formed by the fifth and sixth nerves and the communication from the fourth. The seventh nerve alone forms the *middle trunk*; and the *lowest trunk* is formed by the eighth cervical and first thoracic nerves and the communication from the second thoracic. Almost immediately after their formation the trunks divide into anterior and posterior divisions, and the divisions reunite to form *three cords*, lateral, medial, and posterior. The *lateral cord* is formed by the anterior divisions of the upper and middle trunks, the *medial cord* by the anterior division of the lowest trunk, and all three posterior divisions unite to form the *posterior cord*. The cords descend behind the clavicle and subclavius muscle, and through the cervico-axillary canal, to the level of the coracoid process of the scapula where the plexus terminates and each cord divides into two *terminal branches*. The terminal branches of the lateral cord are the lateral head of the median nerve and the musculo-cutaneous nerve. Those of the medial cord are the medial head of the median and the ulnar nerve, and the posterior cord divides into the axillary

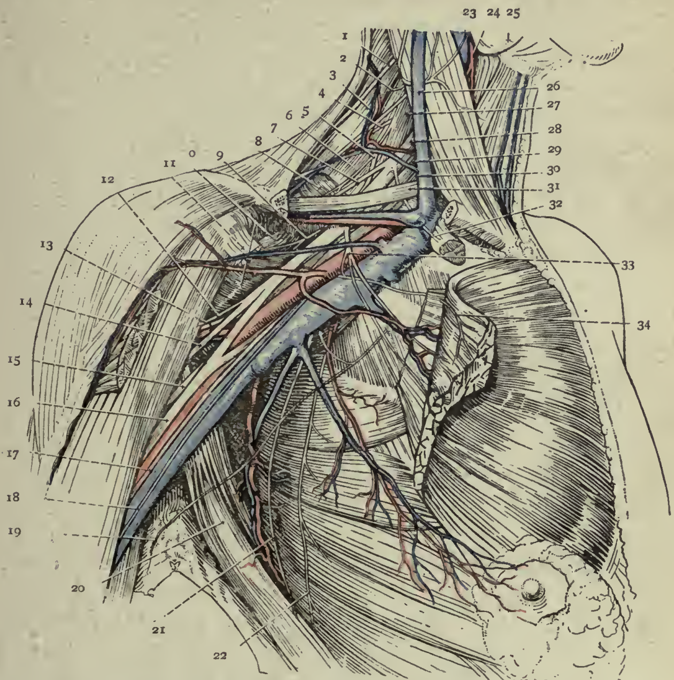


FIG. 16.—Dissection to show the General Relations of the Brachial Plexus.

1. Accessory nerve.
2. Nerve to levator scapulæ.
3. Levator scapulæ.
4. Dorsal scapular nerve.
5. Long thoracic nerve.
6. Scalenus medius.
7. Suprascapular nerve.
8. Serratus anterior.
9. Upper subscapular nerve.
10. Subscapularis.
11. Pectoralis minor.
12. Nerve to coraco-brachialis.
13. Axillary nerve.
14. Musculo-cutaneous nerve.
15. Radial nerve.
16. Median nerve.
17. Medial cutaneous nerve of forearm.
18. Medial cutaneous nerve of arm.
19. Intercosto-brachial nerve.
20. Latissimus dorsi.
21. Thoraco-dorsal nerve.
22. Long thoracic nerve.
23. Internal jugular vein.
24. Superior thyreoid artery.
25. Submaxillary gland.
26. External jugular vein.
27. Scalenus medius.
28. Upper trunk of brachial plexus.
29. Middle trunk of brachial plexus.
30. Eighth cervical nerve.
31. Omo-hyoid.
32. Nerve to subclavius.
33. Lateral anterior thoracic nerve.
34. Medial anterior thoracic nerve.

(O.T. circumflex) nerve and the radial (O.T. musculo-spiral). In addition to the terminal branches, *collateral branches* are given off from the roots, the trunks and the cords; and the roots are connected with the middle and lower ganglia of the cervical part of the sympathetic trunk by grey rami communicantes. The branches given off from the roots are twigs of supply to the longus colli, the scalenus anterior, the scalenus medius, and the scalenus posterior, the roots of origin of the long thoracic nerve, which supplies the serratus anterior (O.T. magnus) and the dorsal scapular nerve (O.T. nerve to the rhomboids). The roots of the long thoracic nerve spring from the fifth, sixth, and seventh nerves; the upper two pierce the scalenus medius and the lowest passes anterior to that muscle. The three unite, behind the trunks of the plexus, to form the stem of the nerve, which descends behind the cords of the plexus into the axilla. The dorsalis scapulæ nerve arises from the lateral border of the fifth nerve; it disappears under cover of the levator scapulæ and supplies the two rhomboid muscles, and, sometimes, the levator scapulæ.

The branches from the trunks of the plexus are the suprascapular nerve and the nerve to the subclavius. They both spring from the upper trunk. The collateral branches of the three cords of the plexus are—(1) from the lateral cord: the lateral anterior thoracic nerve; (2) from the posterior cord: the upper and lower subscapular nerves and the thoracodorsal nerve (O.T. long subscapular); and (3) from the medial cord: the medial anterior thoracic, the medial cutaneous nerve of the arm (O.T. lesser internal cutaneous) and the medial cutaneous nerve of the forearm (O.T. internal cutaneous).

The Position of the Brachial Plexus.—The plexus lies (1) in the lower and anterior part of the posterior triangle of the neck, partly above and partly below the posterior belly of the omo-hyoid; (2) posterior to the clavicle; and (3) in the axilla. *Above the clavicle* it is covered by the skin, the superficial fascia and the platysma, branches of the supraclavicular nerves, the first layer of deep fascia, the external jugular vein, and the terminal parts of the transverse cervical and transverse (supra) scapular veins; the second layer of deep cervical fascia, the transverse cervical artery, the posterior belly of the omo-hyoid, the nerve to the subclavius, and the third part of the subclavian artery. *Behind the clavicle* it is crossed superficially by the transverse scapular artery (O.T.

suprascapular). *Below the clavicle* it is covered by the skin and superficial fascia, the platysma, the middle supraclavicular nerves, the deep fascia, the pectoralis major, the pectoralis minor, the cephalic vein, the branches of the thoraco-acromial artery, the costo-coracoid membrane, and the axillary artery and vein (Figs. 15, 16, 49, 51).

Its posterior relations in the neck are the scalenus medius and the long thoracic nerve. *Its posterior relations in the axilla* are the serratus anterior, the fat in the interval between the serratus anterior and the subscapularis, and, finally, the subscapularis itself.

After the brachial plexus has been examined, the clavicle must be replaced in position and the skin flap, reflected from the posterior triangle, must be replaced and fixed in position by a few sutures.

On the ninth day after the body is brought into the room, that is, on the sixth day after it has been placed on its back, it will be turned upon its face, with the thorax and the pelvis supported by blocks. The body will remain upon its face for five days, and during that period the dissectors of the head and neck must complete the dissection of the posterior part of the scalp; dissect the muscles, vessels and nerves of the back and the sub-occipital region; and remove and examine the spinal medulla.

THE DISSECTION OF THE BACK.

Dissection.—Make a median longitudinal incision from the external occipital protuberance to the seventh cervical spine, and a second incision laterally from the seventh cervical spine to the acromion, and throw the flap laterally. When that has been done the posterior triangle will be exposed from behind, and the dissector should take the opportunity of noting the positions of the contents and the constituent parts of the floor from that aspect. Afterwards he must look for the superficial nerves in the superficial fascia over the upper part of the trapezius. If the greater occipital nerve was not found during the dissection of the scalp, secure it at once, as it pierces the deep fascia covering the upper end of the trapezius, about midway between the external occipital protuberance and the posterior border of the mastoid portion of the temporal bone; trace it upwards through the dense superficial fascia of the scalp, and clean the branches of the occipital artery which are distributed in the same region. The third occipital nerve will be found in the superficial fascia between the greater occipital and the median plane. It is the medial division of the posterior ramus of the third cervical nerve, and it supplies the skin of the medial and lower part of the posterior portion of the scalp and the adjacent part of the skin of the back of the neck. Trace it upwards to its termination, and downwards to the point where it pierces the deep fascia covering the trapezius. At a still lower level look for the medial divisions of the posterior rami of the other cervical nerves. They are variable in number and position, but those which are present will be found piercing the deep fascia over the trapezius, at a short distance from the median plane, and running downwards and laterally towards the posterior triangle.

After the cutaneous nerves have been found remove the remains of the superficial fascia and the deep fascia from the surface of the trapezius.

The Terminal Part of the Greater Occipital Nerve.—The greater occipital nerve is the large medial division of the posterior ramus of the second cervical nerve. It enters the posterior part of the scalp, after piercing the upper part of the trapezius and the deep fascia of the back of the neck, and it ramifies in the superficial fascia of the scalp over the occipital bone and the posterior part of the parietal bone. It is accompanied by the branches of the occipital artery, and it communicates with the great auricular and lesser occipital nerves.

Arteria Occipitalis.—After the occipital artery emerges from between the trapezius and the sterno-mastoid, at the apex of the posterior triangle, or pierces the upper part of the trapezius, its terminal part pierces the deep fascia of the back of the neck and enters the superficial fascia of the posterior part of the scalp. It anastomoses with its fellow of the opposite side, and with the posterior auricular and the superficial temporal arteries. As a rule, it breaks up into two main branches, a lateral and a medial. The medial branch gives off cutaneous twigs and a meningeal branch, which passes through the parietal foramen and anastomoses with a branch of the middle meningeal artery. Through the same foramen, passes an emissary vein which connects the occipital veins with the superior sagittal (longitudinal) sinus.

Musculus Trapezius.—The trapezius and latissimus dorsi constitute the first layer of the muscles of the back. Only that part of the trapezius which lies above the level of the seventh cervical spine belongs to the dissector of the head and neck; the lower part and the latissimus must be cleaned by the dissector of the arm, but the dissector of the head should take the opportunity to revise his knowledge of the whole origin and insertion of the trapezius. It arises from the medial third of the superior nuchal line of the occipital bone, the external occipital protuberance, the whole length of the ligamentum nuchæ, the seventh cervical spine, the tips of all the thoracic spines and the corresponding supraspinous ligaments.

In the region of the seventh cervical spine the origin is more aponeurotic than elsewhere, and the fine tendinous

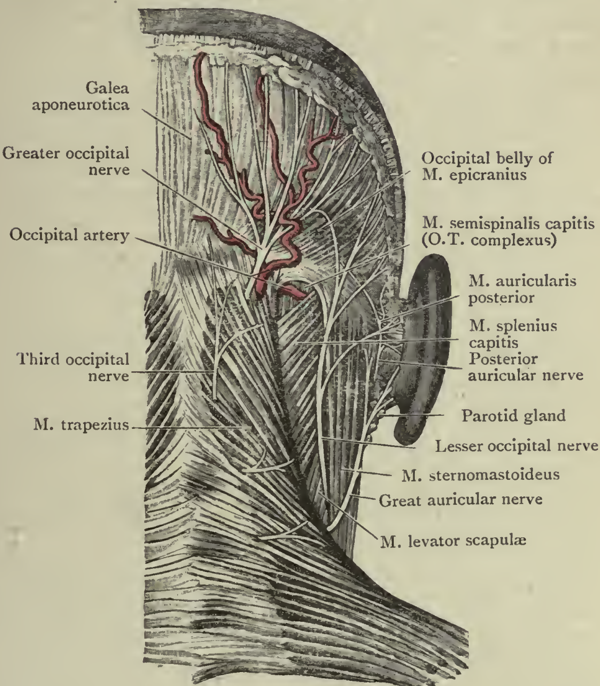


FIG. 17.—Superficial dissection of the Back of the Neck.

fibres of the muscles of the two sides form an ovoid aponeurotic area some two inches in length.

The upper fibres of the muscle descend in oblique curves and are inserted into the lateral third of the posterior border and the adjacent part of the superior surface of the clavicle; the middle fibres run horizontally, towards the shoulder, and are inserted into the medial border of the acromion and the upper lip of the posterior border of the spine of the scapula. The lower fibres ascend, and terminate in a small triangular tendon which plays over the smooth triangle at the root of the scapular spine, and which is inserted partly into the lower lip and partly into the upper lip of the spine. The muscle is supplied by the accessory and the third and fourth cervical nerves. It draws the scapula medially and braces the shoulder backwards, raises the tip of the shoulder, or depresses the scapula and turns the glenoid fossa upwards, according to whether the middle, the upper, or the lower fibres are mainly in action.

Dissection.—On the second day after the subject has been placed on its face, the dissector, in conjunction with the dissector of the superior extremity, must reflect the trapezius muscle. First separate the muscle from the occipital bone, and then divide it about half an inch from the spines of the vertebræ. The muscle can now be raised and thrown laterally towards its insertion. On its deep surface the accessory nerve, the twigs of supply from the third and fourth cervical nerves and the ascending branch of the transverse cervical artery will be noticed. It is the duty of the dissector of the upper limb to dissect the structures mentioned, but the dissector of the head and neck should trace the artery to its origin from the transverse cervical artery.

The attachments of the levator scapulæ also must be defined. Two twigs from the third and fourth cervical nerves, which lie on its surface and finally enter its substance, have already been secured. Further, passing downwards under cover of the levator scapulæ muscle, the dorsal scapular nerve (O.T. nerve to the rhomboids) and the descending branch (O.T. posterior scapular) of the transverse cervical artery will be found. Almost invariably the dorsal scapular nerve gives one or two twigs to the levator scapulæ.

The levator scapulæ, the rhomboids, the posterior serrati and the splenius are classed as muscles of the second layer. The rhomboids and the lower part of the levator belong to the dissector of the arm ; the remaining muscles are the property of the dissector of the head and neck.

Musculus Levator Scapulæ.—The levator scapulæ arises by four slips from the posterior parts of the transverse processes of the upper four cervical vertebræ. The slips unite to form an elongated muscle which extends downwards and backwards to be inserted into that portion of the vertebral border of the scapula which is placed above the level of the spine. Its nerve-supply is derived from the third and fourth cervical nerves, and also from the dorsal scapular nerve. The muscle raises the scapula and draws it towards the vertebral column.

The origin of the posterior belly of the omo-hyoid muscle may now be examined. It is attached to the upper transverse ligament of the scapula and the adjacent part of the superior border of the bone. The transverse scapular artery (O.T. suprascapular) will be noticed passing over the upper transverse ligament, whilst the suprascapular nerve traverses the notch below it.

Dissection.—The *second day's* work is now completed, and on the *same day* the dissector of the upper limb must finish his share of the dissection of the back, so as to allow the dissector of the head and neck to begin the examination of the deeper structures on the dorsal aspect of the trunk.

Three days are allowed for the dissection of the deeper structures of the back. The work may be arranged in the following manner :—On the *first day*, all the muscles, fasciæ, nerves, and blood vessels of the back, with the exception of those in connection with the sub-occipital triangle, should be studied ; on the *second day*, the sub-occipital triangle may be examined ; and on the *third day* the medulla spinalis (O.T. spinal cord) must be displayed.

Commence work on the third day after the body has been placed on its face by cleaning the posterior serrate muscles. They are two in number, superior and inferior. The superior has been exposed by the removal of the trapezius, and the rhomboids and the inferior by the removal of the latissimus dorsi. Both pass from the spines of the vertebræ to the ribs, the superior in a downward and lateral direction to some of the upper ribs, and the inferior in an upward and lateral direction to the lower four ribs.

Musculi Serrati Posteriores.—The posterior serrate muscles are two thin sheets of fleshy fibres, which are placed upon the posterior aspect of the thoracic wall. The *serratus posterior superior* is much the smaller of the two ; it arises by a thin aponeurotic tendon from the lower part of the ligamentum nuchæ ; from the spinous process of the seventh cervical vertebra ; and from the spinous processes of the upper two or three thoracic vertebræ. It passes obliquely downwards and laterally, and is inserted into the outer surfaces of the second, third, fourth, and fifth ribs, a short distance anterior to their angles.

The *serratus posterior inferior* takes origin from the spinous processes of the last two thoracic and upper two lumbar vertebræ, and the supraspinous ligaments between them. The dissector will note, however, that this is not an independent and distinct attachment, but that it is effected through the medium of the lumbo-dorsal fascia, with which the aponeurotic tendon of the muscle blends. The muscle passes upwards and laterally and is inserted into the outer surfaces of the lower four ribs. The superior serratus elevates the ribs to which it is attached, and is therefore a muscle of inspiration. It is supplied by the anterior rami of the second, third, and fourth thoracic nerves. The inferior serratus helps to fix the lower ribs and so facilitates the action of the diaphragm. Therefore, indirectly, it also is a muscle of inspiration. It is supplied by the anterior rami of the lower thoracic nerves.

Fascia Lumbo-dorsalis.—After the posterior serrate muscles have been displayed and examined on the third day after the

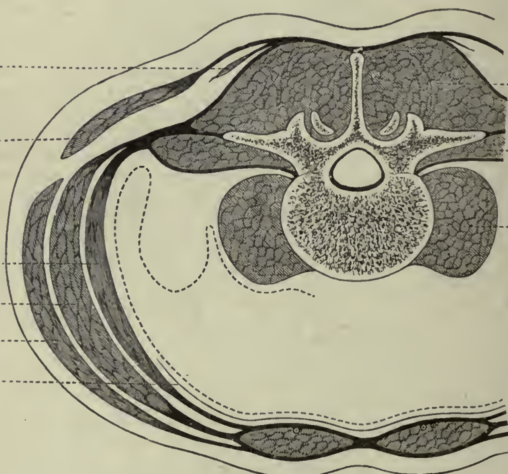


FIG. 18.—Diagram to show the Connections of the Lumbo-dorsal Fascia.

body is placed upon its face, the dissector of the head and neck should associate himself with the dissector of the abdomen in the examination of the lumbo-dorsal fascia. It is an aponeurotic layer, thin in the thoracic portion of its extent, but thick and strong in the lumbar and sacral regions. In all three regions it binds down the deeper muscles of the back to the sides of the spinous processes and to the transverse processes of the vertebræ.

The Thoracic Part of the Lumbo-dorsal Fascia (O.T. *Vertebral Aponeurosis*) is a thin transparent lamina which extends from the tips of the spines and the supraspinous ligaments to the angles of the ribs. At the upper end of the thoracic region it dips beneath the serratus posterior superior into the neck, and at the lower end it blends with the aponeurosis of origin of the serratus posterior inferior, and, through that, becomes continuous with the posterior layer of the lumbar portion.

Dissection.—To display the lumbar part of the lumbo-dorsal fascia, take away the remains of the origin of the latissimus dorsi, which springs from its posterior surface, and then reflect the serratus posterior inferior by cutting through it at right angles to its fibres and turning it medially and laterally towards its origin and insertion. As the lateral part is turned aside secure its nerves of supply; they are derived from the owers intercostal nerves, and enter its deep surface. Next, remove the remains of the origin of the serratus posterior inferior, and then the posterior layer of the lumbar part of the lumbo-dorsal fascia will be completely exposed.

The Lumbar Part of the Lumbo-dorsal Fascia is separable into three lamellæ, a posterior, a middle, and an anterior. All three fuse together laterally, where they become connected with the internal oblique and the transversus abdominis muscles. The *posterior layer*, which is the strongest of the three, is a dense tendinous aponeurosis. It is continuous *above* with the thoracic part. *Below*, it is attached to the posterior part of the outer lip of the iliac crest, and to the dorsum of the sacrum and the coccyx. *Medially*, it is attached to the tips of the spines of the lumbar and sacral vertebræ; and *laterally* it blends with the posterior surface of the middle lamella (Fig. 18). The aponeurosis of origin of the latissimus dorsi and the serratus posterior inferior arise from its posterior surface.

Dissection.—Make a longitudinal incision through the posterior layer of the lumbar part of the lumbo-dorsal fascia, midway between its medial and its lateral borders. At each end of the longitudinal incision make a transverse incision, extending from the spines medially to the lateral border of the rounded mass of spinal muscles lying under cover of the fascia. Turn the medial part of the divided fascia towards the median plane, and verify its attachment to the vertebral spines and the supraspinous ligaments. Pull the lateral part aside, and at the lateral border of the mass of posterior spinal muscles note that it blends with a deeper middle lamella. Push the mass of posterior spinal muscles towards the median plane, and follow the middle lamella of the fascia to its attachment.

The *middle lamella* is attached, medially, to the tips of the transverse processes of the lumbar vertebræ; below, to the iliac crest, and, above, to the last rib. Laterally, it blends with the posterior and anterior lamellæ, and, immediately lateral to its line of union with the posterior lamella, the internal oblique arises from its posterior surface. To expose it thoroughly the mass of posterior spinal muscles must be pushed medially.

Dissection.—After the middle lamella has been examined divide it longitudinally, close to its attachment to the tips of the transverse processes, and transversely along the line of the iliac crest, and turn it laterally. A considerable part of the posterior surface of the quadratus lumborum muscle will then be exposed. Displace the lateral border of the quadratus lumborum towards the median plane, and the anterior lamella of the lumbar part of the lumbo-dorsal fascia will be brought into view.

The *anterior lamella* of the lumbar part of the lumbo-dorsal fascia is attached, medially, to the anterior surfaces of the roots of the transverse processes of the lumbar vertebræ; laterally, it blends with the fused middle and posterior lamellæ to form the common aponeurosis of origin of the transversus abdominis muscle, and it is by means of the three lamellæ of the lumbar fascia that the latter muscle arises from the tips of the spines, and from the tips and the roots of the transverse processes of the lumbar vertebræ. The upper border of the anterior lamella becomes thickened, and extends, anterior to the quadratus lumborum, from the last rib to the transverse process of the first lumbar vertebra, as the *lateral lumbo-costal arch* (O.T. external arcuate ligament); the lower border blends with the ilio-lumbar ligament. The dissector should verify the various attachments by passing his fingers over the posterior surface of the lamella from its lateral to its medial border, and from its upper to its lower end.

Dissection.—After satisfying himself regarding the lamellæ of the lumbar part of the lumbo-dorsal fascia and their relations to the posterior spinal muscles, to the quadratus lumborum, and to the internal oblique and the transversus abdominis muscles, the dissector should make a longitudinal incision through the anterior lamella, and the peri-nephric fascia anterior to it; and, introducing his finger through the opening into the extra-peritoneal fatty tissue, he should scrape away the latter until he exposes the kidney, below the level of the last rib, and the adjacent part of the colon, which lies along the lower and lateral part of the kidney. After that has been done he should reflect the serratus posterior superior and secure its nerves of supply, which spring from the upper intercostal nerves and enter its deep surface; then he should remove the thoracic part of the lumbo-dorsal fascia and commence the study of the posterior spinal muscles, beginning with the splenius.

Musculus Splenius.—The splenius has a continuous origin from the lower half of the ligamentum nuchæ, and from the spines of the seventh cervical and upper six thoracic vertebræ. Its fibres pass obliquely upwards and laterally, forming a thick flat muscle, which soon divides into a cervical and a cranial portion, termed respectively the splenius cervicis and the splenius capitis.

The *splenius cervicis* turns forwards and is inserted, by tendinous slips, into the posterior tubercles of the transverse processes of the upper two or three cervical vertebræ, medial to the levator scapulæ.

The *splenius capitis* passes under cover of the upper part of the sterno-mastoid muscle, and gains insertion into the lower part of the mastoid portion of the temporal bone and into the lateral portion of the superior nuchal line of the occipital bone. To see the insertion, the sterno-mastoid muscle may be divided along the superior nuchal line, but it must not be detached from the temporal bone. The splenius capitis and cervicis bend the head and neck respectively backwards and turn them to the side on which the muscles lie. The splenius capitis and splenius cervicis are supplied by the posterior rami of the cervical nerves.

Dissection.—The deeper spinal muscles must now be dissected. Begin by reflecting the splenius muscle. Detach it from its origin and throw it laterally and upwards towards its insertion. Whilst doing that preserve the cutaneous branches of the cervical nerves which pierce the muscle.

When the splenius capitis is fully reflected, a small triangular space will be noticed close to the superior nuchal line of the occipital bone. Anteriorly, it is bounded by the longissimus capitis (O.T. trachelo-mastoid); posteriorly, by the lateral border of the semispinalis capitis (O.T. complexus); and above, by the superior nuchal line of the occipital bone. The floor of the little space is formed by the superior oblique muscle of the head, and it is traversed by the occipital artery, which in that part of its course gives off its descending branch (O.T. arteria princeps cervicis), and its meningeal branch.

The Third Layer of Muscles.—Under this head are included a series of muscular strands which stretch, with a greater or less degree of continuity, along the entire length of the dorsal aspect of the vertebral column. In the lumbar region they constitute a bulky fleshy mass which may be considered the main starting-point. The mass is the **musculus sacro-spinalis**, which has the following origins:—(1) from the spines of all the lumbar vertebræ; (2) from the supraspinous ligaments which bind the lumbar spines together; (3) from the dorsum of the sacrum and from the posterior sacro-iliac ligament; (4) from the posterior fifth of the iliac crest; (5) from the deep surface of the posterior layer of the lumbo-dorsal fascia. In great part the superficial surface of this muscular mass is covered by and is adherent to the posterior layer of the lumbo-dorsal fascia.

Superiorly, the sacro-spinalis divides into three columns. The lateral column first separates from the general mass, and to it the name of *ilio-costalis* is given ; the intermediate column is termed the *longissimus*, and the medial column, which becomes quite distinct only as the upper part of the thoracic region is approached, is called the *spinalis*. The semispinalis muscle also is included in the third layer.

The **Ilio-costalis** is a column of muscular bundles which extends from the lumbar to the cervical region. It is separable into three segments, known, from below upwards, as the ilio-costalis lumborum, the ilio-costalis dorsi, and the ilio-costalis cervicis.

Ilio-costalis Lumborum.—The lumbar part of the ilio-costalis muscle and the longissimus dorsi become distinct at the level of the last rib, and the interval between them is marked by the exits of the lateral divisions of the posterior rami of lower thoracic nerves.

The ilio-costalis lumborum ends above in a series of six or seven slender tendons, which are inserted into the angles or the corresponding parts of the lower six or seven ribs.

The *Ilio-costalis Dorsi* (O.T. *Musculus Accessorius*) arises by six or seven slender tendons from the angles of the lower ribs, on the medial sides of the tendons of insertion of the ilio-costalis lumborum, and it is inserted by a series of similar tendons into the angles of the upper six ribs and to the transverse process of the seventh cervical vertebra.

The Ilio-costalis Cervicis (O.T. *Cervicalis Ascendens*) is the highest segment of the ilio-costalis. It arises, on the medial side of the ilio-costalis dorsi, by four slips which spring from the third, fourth, fifth, and sixth ribs ; it is inserted into the transverse processes of the fourth, fifth, and sixth cervical vertebræ.

> ***Dissection.***—**To display the ilio-costalis properly, the dissector should first evert the lowest segment, and then in turn the middle and upper segments aside, but whilst doing that he must take care to preserve the lateral divisions of the posterior rami of the spinal nerves.**

The **Longissimus** is the middle and largest of the three muscle columns. It extends upwards, through the thoracic and cervical regions, to the head, and it also is separable into three segments : longissimus dorsi, longissimus cervicis, and longissimus capitis.

> ***Dissection.***—**The interval between the longissimus and the spinalis is frequently difficult to define, but if the fascia is carefully cleaned from the lateral to the medial border of the longissimus, in the upper thoracic region, the separation will become apparent, and after it has been found the attachments of the longissimus must be defined. The muscle being displaced to the medial and lateral sides as may be necessary.**

Longissimus Dorsi.—The thoracic part of the longissimus possesses two rows of slips of insertion : a medial row of tendinous slips which are attached to the tips of the transverse processes of the thoracic and the accessory processes of the lumbar vertebræ, and a lateral row of muscular slips which are inserted into the lower ten ribs, on the lateral sides of their tubercles, and to the transverse processes of the lumbar vertebræ, and to the posterior surface of the middle lamella of the lumbar fascia.

Longissimus Cervicis (O.T. *Transversalis Cervicis*).—The cervical portion of the longissimus springs from the transverse processes of the upper four thoracic vertebræ, and is inserted into the posterior tubercles of the transverse processes of the cervical vertebræ from the second to the sixth inclusive.

Longissimus Capitis (O.T. *Trachelo-mastoid*).—The longissimus capitis lies in the neck, under cover of the splenius. It arises, in common with the longissimus cervicis, from the transverse processes of three or four of the upper thoracic vertebræ, and, in addition, from the articular processes of a like number of the lower cervical vertebræ. The narrow, fleshy band which results is inserted into the posterior part of the mastoid portion of the temporal bone, under cover of the splenius capitis and sterno-mastoid muscles.

Musculus Spinalis.—The spinalis muscle is the most medial, shortest, and weakest of the three columns, and the most difficult to define. Below, it is intimately blended with the longissimus dorsi, but it may be regarded as taking origin by four tendons from the spines of the upper two lumbar and lower two thoracic vertebræ. The tendons end in a small muscular belly, which is inserted by a series of slips into a very variable number of the upper thoracic spines. It is closely connected with the subjacent semi-spinalis dorsi.

Spinalis Cervicis.—This upward prolongation of the spinalis is not always easy to define. It springs from the spines of the lower four cervical vertebræ and is inserted into the spines of the second, third, and fourth cervical vertebræ.

The various segments of the sacro-spinalis are supplied by the posterior rami of the spinal nerves. When the segments on one side only act they bend the vertebral column to that side, but when the segments on both sides act simultaneously they bend the vertebral column backwards.

> ***Dissection.*—The occipital artery has already been seen crossing the apex of the posterior triangle (p. 36), and its terminal branches have been dissected as they ramify in the scalp (p. 55). To expose the second part of the vessel, which extends from under shelter of the mastoid process, along the superior nuchal line of the occipital bone, to the point where it pierces the trapezius to become superficial, divide the longissimus capitis (O.T. trachelo-mastoid) a short distance below its insertion, and throw it upwards as far as possible, along with the splenius capitis; then clean the artery.**

Arteria Occipitalis.—In the region of the mastoid process the second part of the occipital artery is very deeply placed; indeed, no less than five structures lie superficial to it. These are (enumerating them in order from the vessel to the surface)—(1) the origin of the posterior belly of the digastric muscle; (2) the mastoid process; (3) the longissimus capitis; (4) the splenius capitis; and (5) the sterno-mastoid.[1] As the artery runs backwards, it very soon emerges from under cover of the first three of the structures mentioned, and a little farther on it leaves the shelter of the splenius, and is then covered by the sterno-mastoid alone. Issuing from

[1] It is not uncommon to find the artery between the splenius and the longissimus capitis, as in Fig. 20.

under cover of the posterior border of that muscle, the artery crosses the apex of the posterior triangle, and disappears under the trapezius, which it pierces afterwards, near the external occipital protuberance, to reach the scalp. Two muscles constitute its deep relations—viz., the insertions of the superior oblique and the semispinalis capitis (O.T. complexus) (Fig. 20).

The following *branches* may be traced from the second portion of the occipital artery: (1) ramus descendens (O.T. arteria princeps cervicis); (2) meningeal; (3) muscular.

The *descending branch* (O.T. *arteria princeps cervicis*) is a twig of some size, which passes medially to the lateral border of the semispinalis capitis (O.T. complexus); there it divides into a superficial and a deep branch. The former ramifies on the surface of the semispinalis capitis, whilst the latter sinks under that muscle, where it will be followed to its anastomosis with the deep cervical artery at a later stage in the dissection.

The small *meningeal branch* enters the posterior cranial fossa through the mastoid foramen, and supplies the dura mater and cranial wall in the mastoid region.

The *muscular twigs* go to the neighbouring muscles.

The *veins* corresponding to the occipital artery are two, or perhaps three, in number. They drain the blood from the occipital portion of the scalp, and open into the sub-occipital plexus, which is drained by the vertebral and deep cervical veins. The most lateral of the occipital veins frequently communicates with the transverse sinus (O.T. lateral sinus) through the mastoid foramen.

Dissection.—The semispinalis capitis, which has been exposed by the reflection of the splenius and the turning aside of the longissimus cervicis and longissimus capitis, must now be cleaned, and whilst that is being done and the attachments of the muscle are being defined, care must be taken of the medial divisions of the posterior rami of the second, third, fourth, and fifth cervical nerves. The first of the three—or, in other words, the greater occipital—from its great size, runs little risk of injury, but the others are liable to be overlooked. They all emerge from the substance of the muscle close to the median plane.

Musculus Semispinalis Capitis (O.T. *Complexus*).—The semispinalis capitis is the uppermost part of a muscular column consisting of three segments, which are spoken of collectively as the semispinalis, and individually as the semispinalis dorsi, the semispinalis cervicis, and the semispinalis capitis. It belongs to the third layer of muscles, of which the greater number have been dissected already. The lower two segments will be dissected subsequently, but it is convenient to examine the semispinalis capitis at once. It is a thick fleshy mass which springs by tendinous slips from the transverse processes of the upper six thoracic vertebræ and the articular processes of the fourth, fifth, and sixth cervical vertebræ. Its massive upper extremity is inserted into a somewhat oval area on the occipital bone, between the superior and inferior nuchal lines close to the external occipital crest. It is separated from its fellow muscle of the opposite side by the ligamentum nuchæ; and its most medial part, which is to a certain extent distinct from the general mass, is divided into two bellies by an intermediate tendon, and is spoken of as the *biventer cervicis.* Occasionally the remainder of the muscle is also intersected by a tendinous septum.

The semispinalis capitis bends the head backwards. It is supplied by the posterior rami of the upper cervical nerves.

Dissection.—The semispinalis capitis must now be reflected by detaching it from the occiput and throwing it laterally. Care must be exercised, not only on account of the nerves which have been seen to perforate the muscle to reach the surface, but also on account of the structures which it covers. In its upper part it lies over the sub-occipital triangle and the muscles bounding it, whilst, below, it covers the semispinalis cervicis. A thick, dense fascia is placed over the subjacent parts, and in the fascia lie certain of the cervical nerves and the anastomosis between the descending branch of the occipital artery and the arteria profunda cervicis. The dissector must specially look for a small twig from the posterior ramus of the sub-occipital nerve which enters the deep surface of the upper part of the semispinalis capitis, and for a larger branch to the same muscle from the greater occipital nerve.

As soon as the twig to the semispinalis capitis is secured the dissector should cut out a small piece of the muscle to which the nerve goes, and leave it attached to the nerve to serve as a guide to the other branches of the sub-occipital nerve when the boundaries and contents of the sub-occipital triangle are being dissected (see p. 75).

Ligamentum Nuchæ.—When the semispinalis capitis has been turned aside the corresponding surface of the ligamentum nuchæ will be exposed (Fig 19). The ligament is a strong and fibrous partition, placed in the median plane, between the muscles on each side of the back of the neck. It represents a powerful elastic structure in quadrupeds, which helps to sustain the weight of the dependent head. In man, however, there is not much elastic tissue developed in connection with it, and it appears to be a continuation upwards of the supraspinous ligament from the spine of the seventh cervical vertebra to the external occipital protuberance. In shape it is somewhat triangular. By its base it is attached to the external occipital crest; by its anterior border it is fixed by a series of slips to the posterior tubercle of the atlas, and to the bifid spines of the cervical vertebræ, in the intervals between their tubercles. Its

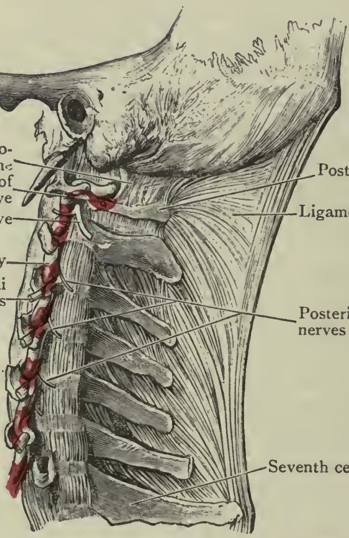


FIG. 19.—Dissection of the Ligamentum Nuchæ and of the Vertebral Artery in the Neck.

apex is attached to the spine of the seventh cervical vertebra, whilst its posterior border is, in a measure, free, and gives origin to the trapezius, rhomboid, serratus posterior superior, and splenius muscles

Arteria Profunda Cervicis.—The *deep cervical artery* springs from the costo-cervical branch of the subclavian, and reaches the back of the neck by passing between the transverse process of the last cervical vertebra and the neck of the first rib. At the present stage of the dissection it is seen ascending upon the semispinalis cervicis muscle and anastomosing with the descending branch of the occipital. Both vessels anastomose with twigs from the vertebral artery.

The arteria profunda cervicis is accompanied by a large vein—the *vena profunda cervicis.* That vessel begins in the sub-occipital plexus, and it ends in the vertebral vein close to its termination. It reaches its termination by turning forwards under the transverse process of the last cervical vertebra.

Posterior Rami of the Spinal Nerves.—The nerves of the back must now be examined. They are the posterior rami of the spinal nerves. With *four* exceptions (viz., the first cervical, fourth and fifth sacral, and the coccygeal nerves), each posterior ramus will be found to divide into a *lateral* and a *medial division.*

Examine the nerves successively in the cervical, thoracic, and lumbar regions. It is well, however, to defer the dissection of the sacral and coccygeal nerves until the multifidus muscle has been studied.

Cervical Region.—In the neck the posterior rami of the spinal nerves are eight in number. The posterior ramus of the *sub-occipital* or *first spinal nerve* fails to divide into a medial and a lateral division. It lies deeply in the sub-occipital triangle, and will be examined when that space is dissected.

The posterior ramus of the *second cervical nerve* is very large. It appears between the vertebral arches of the first and the second cervical vertebræ. The posterior rami of the succeeding *six cervical nerves* arise from the corresponding spinal nerve-trunks in the intervertebral foramina, but they turn dorsally, on the medial sides of the posterior inter-transverse muscles, and appear in the intervals between the transverse processes.

The *lateral divisions* are of small size, and are entirely devoted to the supply of adjacent muscles.

The *medial divisions* are not all distributed alike, nor indeed do they present the same relations. Those from the *second*, *third*, *fourth*, and *fifth nerves* run medially towards the spinous processes, superficial to the semispinalis cervicis muscle, and under cover of the semispinalis capitis. When close to the median plane they turn backwards, pierce the semispinalis capitis, splenius, and trapezius muscles, and become superficial. In their course to the surface they give numerous twigs to the neighbouring muscles.

The medial division of the second nerve is remarkable for its large size. It receives the special name of *greater occipital.* It will be noticed turning round the lower border of the inferior oblique muscle, to which it supplies some twigs. In passing to the surface it pierces the semispinalis capitis (O.T. complexus) and trapezius. To the former it gives several twigs. The distribution of this nerve on the occiput has been noticed already (p. 56).

The medial division of the third nerve also sends an offset to the occipital portion of the scalp (p. 55).

The medial divisions of the *lower three* posterior rami of the cervical nerves resemble the preceding, in so far that they take a course medially towards the spinous processes. They differ from them, however, in running deep to the semispinalis cervicis, and in being, as a rule, entirely expended in the supply of muscles.

Thoracic Region.—The posriteor rami of the thoracic nerves make their appearance in the intervals between the transverse processes. The *lateral divisions* proceed laterally, under cover of the longissimus muscle, and appear in the interval between the longissimus dorsi on the one hand and the ilio-costalis on the other. The *upper six or seven* of the nerves are exhausted in the supply of the intermediate and lateral columns of the sacrospinalis; the *lower five or six*, however, are considerably larger, and contain both motor and sensory fibres. After giving up their motor fibres to the muscles, they become superficial, by piercing the serratus posterior inferior and the latissimus dorsi, in line with the angles of the ribs. Their cutaneous distribution has already been examined by the dissector of the upper limb.

The *medial divisions* also are distributed differently in the upper and lower portions of the thoracic region. The *lower five or six* are very small, and end in the multifidus muscle. The *upper six or seven* pass medially between the multifidus and semispinalis, and, after supplying the muscles between which they are situated, they become superficial. In passing towards the surface they pierce the splenius, rhomboids, and trapezius muscles, and thus gain the superficial fascia, where they have been dissected already.

Lumbar Region.—The *medial divisions* of the posterior rami of the five lumbar nerves are small, and, like the corresponding twigs in the lower thoracic region, they have a purely muscular distribution. They end in the multifidus.

The *lateral divisions* sink into the substance of the sacro-spinalis, and are concerned in the supply of that muscle, and also of the lumbar intertransverse muscles. The lateral divisions of the *upper three lumbar nerves* are of large size, they become cutaneous by piercing the superficial lamella of the lumbo-dorsal fascia. They have already been traced by the dissector of the lower limb to the skin of the gluteal region. The lateral division of the fifth communicates with the corresponding branch of the first sacral nerve.

Blood Vessels of the Back.—In the *cervical region* the dissector has already noticed the arteria profunda cervicis, and the descending branch of the second part of the occipital artery. Deep in the sub-occipital region he will subsequently meet with a small portion of the vertebral artery. In addition, however, minute twigs from the vertebral artery may be discovered, in a well-injected subject, passing backwards in the intervals between the transverse processes, and also in the sub-occipital space. They supply the muscles, and anastomose with the other arteries in that region.

In the *thoracic region* the *posterior branches* of the aortic intercostal arteries and superior intercostal artery make their appearance between the transverse processes. Each of them passes dorsally in the interval between the body of a vertebra and the costo-transverse ligament. It is associated with the corresponding posterior ramus of a spinal nerve, and is distributed, with the nerve, to the muscles and integument of the back.

In the *lumbar region* similar branches are derived from the lumbar arteries. They are distributed in the same manner.

In both thoracic and lumbar regions, before reaching the back, the vessels under discussion furnish small *spinal branches* which enter the vertebral canal through the inter-vertebral foramina. These will be traced at a later period.

The *veins* accompanying the dorsal branches of the lumbar and intercostal arteries pour their blood into the lumbar and intercostal veins. They are of large size, being joined by tributaries from the posterior vertebral venous plexus, and also by others from within the vertebral canal.

Dissection.—The remainder of the third layer of spinal muscles must now be dissected. They are the semispinalis dorsi and semispinalis cervicis. The semispinalis cervicis is already exposed; but to display the semispinalis dorsi it is necessary to remove the spinalis dorsi muscle.

Musculus Semispinalis.—The *semispinalis dorsi* is composed of a series of muscular slips, with long tendons at each end, which arise from the transverse processes of the sixth to the tenth thoracic vertebræ. It is inserted into the spines of the upper four thoracic and lower two cervical vertebræ. The *semispinalis cervicis* lies under cover of the semispinalis capitis. It springs from the transverse processes of the upper five thoracic vertebræ, and is inserted into the spines of the second to the fifth cervical vertebræ. The slips composing the semispinalis muscles stretch over five or more vertebræ. The fibres of the semispinalis run upwards and medially. Therefore they turn the trunk and neck to the opposite side. They are supplied by the posterior rami of the spinal nerves.

***Dissection.*—The fourth layer of muscles must now be examined. It includes the multifidus, the rotatores, the interspinales, the intertransversales, and the recti and oblique muscles of the sub-occipital region. The latter have already been exposed by the reflection of the splenius and semispinalis capitis (complexus). To display the other members of the group the semispinalis dorsi and cervicis must be detached from the spines and drawn aside, and the sacrospinalis must be separated from the lumbar and sacral spines and turned laterally, if that has not already been done in tracing the nerves.**

Musculus Multifidus.—In the *lumbar* and *sacral regions* the multifidus will be seen to constitute a thick fleshy mass which clings closely to the vertebral spines. In that situation it has a very extensive origin—viz., (1) from the deep surface of the aponeurotic origin of the sacrospinalis; (2) from the posterior surface of the sacrum, as low as the fourth aperture; (3) from the posterior sacro-iliac ligament; (4) from the posterior superior spine of the ilium; and (5) from the mamillary processes of the lumbar vertebræ. In the *thoracic region* it takes origin from the transverse processes of the vertebræ, and in the *cervical region* from the articular processes of at least four of the lower cervical vertebræ. Each of the bundles of which the multifidus is composed passes upwards and is inserted into the whole length of the lower border of the spine of the second, third, or fourth vertebra above. The insertions extend from the fifth lumbar vertebra to the second cervical vertebra.

Musculi Rotatores.—The rotator muscles are a series of small muscles which are exposed when the multifidus is pulled aside. In the thoracic region each muscle springs from the root of a transverse process, and is inserted into the lamina of the vertebra immediately above, close to the root of the spinous process. Somewhat similar muscles have been described in the cervical and lumbar regions, and also a series of longer and more superficial slips which connect alternate vertebræ with each other. The multifidus and the rotatores are supplied by the posterior rami of the spinal nerves. They turn the trunk and neck towards the opposite side.

Musculi Interspinales et Intertransversarii.—The *interspinous muscles* can hardly be said to exist in the thoracic region, except in its upper and lower parts, where they are present in a rudimentary condition. In the neck they are arranged in pairs, occupying each interspinous interval, with the exception of that between the first and second cervical vertebræ. In the lumbar region also they are well marked and in pairs: there, they are attached to the whole length of the spinous processes. The *intertransverse muscles* are strongly developed in the lumbar region, and occupy the entire length of the intertransverse intervals. Additional rounded fasciculi may be observed passing between the accessory processes; they are termed the *interaccessorii.* In the *thoracic region* intertransverse muscles—poorly developed—are found only in the lower three or four spaces. In the *cervical region* they are present in pairs and will be examined subsequently.

The interspinous muscles help to bend the vertebral column backwards. The intertransverse muscles bend it towards their own side. Both groups are supplied by the posterior rami of the spinal nerves.

Levatores Costarum.—The elevators of the ribs constitute a series of twelve fan-shaped muscles, which are classified as muscles of the thorax, but they are exposed when the longissimus and ilio-costalis are removed, and therefore should be examined now. They pass from the transverse processes to the ribs. The first muscle of the series springs from the tip of the transverse process of the last cervical vertebra, and, expanding as it proceeds downwards and laterally, it is inserted into the outer border of the first rib, immediately beyond the tubercle. Each of the succeeding muscles takes origin from the tip of a thoracic transverse process, and is inserted into the outer surface of the rib immediately below, along a line extending from the tubercle to the angle. The levatores costarum are muscles of inspiration. They are supplied by the anterior rami of the thoracic nerves.

Posterior Rami of the Sacral Nerves.—The posterior rami of the sacral nerves are very small. The *upper four* will be found emerging from the posterior sacral foramina; the *fifth* appears at the lower end of the sacral canal.

To expose the *upper three*, the multifidus, covering the upper three sacral apertures, must be carefully removed. Each of the three nerves will be found dividing in the usual manner into a medial and lateral division.

The *medial divisions* are very fine, and end in the multifidus.

The *lateral divisions* are somewhat larger, and join together to form a looped plexus upon the dorsum of the sacrum. The plexus communicates, above, with the lateral division of the posterior ramus of the last lumbar nerve and, below, with the posterior ramus of the fourth sacral nerve. Branches proceed from the loops to the surface of the sacro-tuberous ligament (O.T. great sacro-sciatic). Finally, they become superficial by piercing the glutæus maximus muscle, and they supply a limited area of skin over the gluteal region. They have already been examined by the dissector of the lower limb.

The posterior rami of the *lowest two* sacral nerves do not separate into medial and lateral divisions. They are very small, and, after communicating with each other, and also with the *coccygeal nerve*, they distribute filaments to the parts on the posterior aspect of the lower portion of the sacrum and on the dorsal aspect of the coccyx.

Twigs from the lateral sacral arteries accompany the sacral nerves and anastomose with twigs from the gluteal arteries.

Posterior Ramus of the Coccygeal Nerve.—This is a slender twig which emerges from the inferior opening of the sacral canal, and, after being joined by a filament from the last sacral nerve, is distributed on the dorsum of the coccyx.

Posterior Vertebral Venous Plexus.—A plexus of veins is situated upon the superficial aspect of the vertebral arches subjacent to the multifidus muscle. Blood passes to it from the integument and muscles of the back, and is conveyed by it, in the thoracic and lumbar regions, into the posterior tributaries of the intercostal and lumbar veins. In the neck it is especially well marked, and there blood is emptied from it into the vertebral veins. In an ordinary dissection, the plexus is not very noticeable, but it is a source of serious trouble during operations upon the vertebræ (comp. p. 79).

Dissection.—The fourth day after the body is placed upon its face must be devoted to the dissection of the sub-occipital triangle, and the fifth day to the display of the medulla spinalis (O.T. spinal cord), its membranes, nerve-roots, and blood vessels.

If the dissector is pushed for time, it is better that he should proceed at once to expose the spinal medulla (p. 78), and defer the dissection of the sub-occipital region until the head and neck have been removed from the trunk.

Sub-Occipital Space.—The sub-occipital space is a small triangular area, exposed by the reflection of the semi-spinalis capitis (O.T. complexus) and the splenius muscle. It is *bounded* by three muscles—(1) the rectus capitis posterior major forms its upper and medial boundary; (2) the obliquus inferior limits it below; and (3) the obliquus superior bounds it above and to the lateral side. *Its floor* consists of two structures—viz., the posterior arch of the atlas and the thin posterior atlanto-occipital membrane. It *contains* a portion of the vertebral artery and the posterior ramus of the sub-occipital or first cervical nerve (Fig. 20).

Dissection.—The dissection of the sub-occipital space is difficult, because the connective tissue in which its contents lie is dense. The first structures to secure are the posterior ramus of the sub-occipital nerve and its branches. The branch to the semispinalis capitis was retained, with a small piece of the

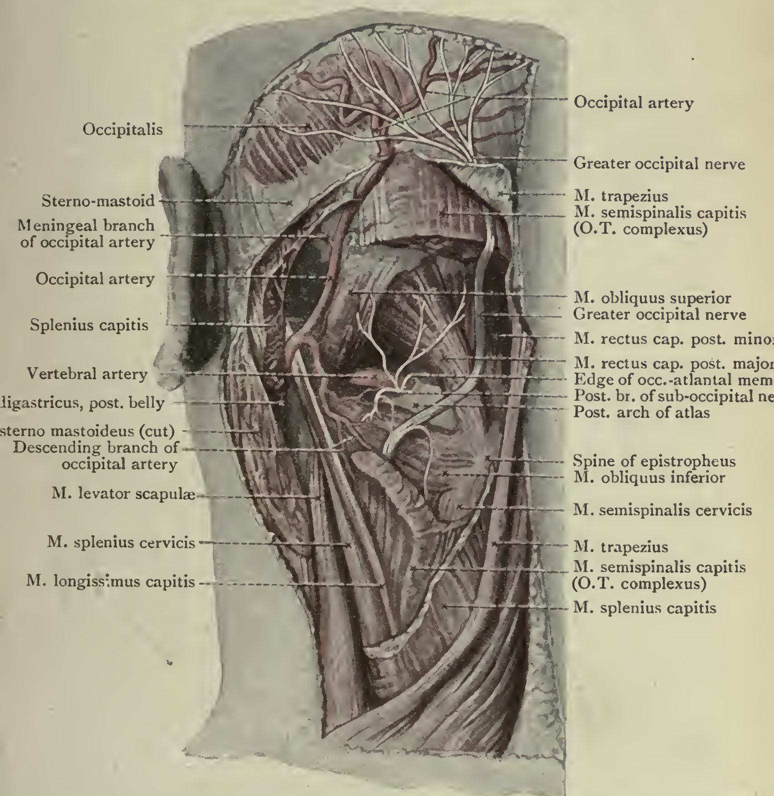


FIG. 20.—Dissection of the Sub-Occipital Region. Note that in this specimen the occipital artery was superficial to the longissimus capitis muscle.

muscle attached to it, when the semispinalis was reflected (p. 67); trace it into the space until it joins the posterior ramus, then follow the other branches from the posterior ramus to their terminations. One branch passes upwards to the superior oblique; one passes upwards and medially to supply the rectus capitis posterior major and the rectus capitis posterior minor; each of the two twigs into which it divides enters the superficial surface of the muscle it supplies, and the twig to the rectus capitis posterior minor crosses the superficial surface of the rectus capitis posterior major; the last branch passes downwards to the inferior oblique muscle; it supplies that muscle and sends a twig of communication to the greater occipital nerve, which in its turn sends a communicating twig to the medial branch of the posterior ramus of the third cervical nerve. The union of the posterior rami of the first three cervical nerves thus formed is called the *posterior cervical plexus*. After the nerves mentioned have been secured and cleaned, clean the muscles which form the boundaries of the space, and afterwards remove the remains of the fascia from the space, and display the posterior arch of the atlas, the third portion of the vertebral artery, which lies on the upper surface of the posterior arch of the atlas above the trunk of the sub-occipital nerve, and the posterior atlanto-occipital ligament.

Musculus Rectus Capitis Posterior Major.—The major posterior rectus muscle of the head springs by a pointed origin from the spine of the epistropheus (O.T. axis), and expanding as it passes upwards and laterally, it is inserted into the occipital bone along the lateral portion of the inferior nuchal line and into the surface immediately below. It draws the head backwards and rotates it to the same side. It is supplied by the posterior ramus of the sub-occipital nerve.

Musculus Rectus Capitis Posterior Minor.—The minor rectus capitis posterior muscle is a small fan-shaped muscle, placed to the medial side of, and overlapped by, the rectus major. It takes origin from the tubercle on the posterior arch of the atlas, and is inserted into the medial part of the inferior nuchal line of the occipital bone and into the surface between that line and the foramen magnum. It draws the head backwards and is supplied by the posterior ramus of the sub-occipital nerve (Fig. 20).

Musculus Obliquus Capitis Inferior.—The inferior oblique muscle extends from the extremity of the spine of the epistropheus to the posterior border of the transverse process of the atlas. The greater occipital nerve will be seen hooking round its lower border. It is supplied by the posterior ramus of the sub-occipital nerve and it rotates the atlas and the head to the same side.

Musculus Obliquus Capitis Superior.—The superior oblique muscle springs from the transverse process of the atlas, and is inserted into the occipital bone, in the interval between the nuchal lines, below and to the lateral side of the semispinalis capitis. Acting with its fellow of the opposite side it draws the head backwards. Acting alone it turns the head slightly to the opposite side. It is supplied by the posterior ramus of the sub-occipital nerve (Fig. 20).

The Actions of the Deep Muscles of the Back.—The dissector will have noted that many of the deep muscles of the back, such as the various prolongations of the sacro-lumbalis, run vertically upwards; others run upwards and medially, viz., the semispinalis dorsi and cervicis and the multifidus spinæ. A third group, exemplified by the splenius capitis and cervicis, the serratus posterior inferior and the inferior oblique muscle, run upwards and laterally. When the muscles which run vertically upwards contract, on one side only, they bend the vertebral column to that side, but if the muscles of both sides act simultaneously they bend the vertebral column backwards. When the muscles which run upwards and laterally contract they turn the head or trunk to the same sides, whilst those which run upwards and medially turn the head or trunk to the opposite side. The muscles which lie at the sides of the sub-occipital space need further consideration. They act either upon the occipito-atlantal joints, the joints between the first and second cervical vertebræ, or upon both sets of joints. At the occipito-atlantal joints backward and forward movement and a slight oblique movement whereby the head is turned a little to one or the other side take place. The main movement between the atlas and the second cervical vertebræ is a movement of rotation, the atlas carrying the head rotating around the dens of the second vertebræ.

The rectus capitis posterior minor and the superior oblique act on the joints between the atlas and occipital bone only: the rectus capitus posterior minor producing backward movement only and the superior oblique backward movement and a very slight oblique movement which turns the head slightly towards the opposite side. The inferior oblique acts only on the joints between the atlas and the second vertebra, turning the head to the same side. The rectus capitis posterior major alone acts on both sets of joints, drawing the head backwards and turning it to the same side.

Posterior Ramus of the Sub-Occipital Nerve.—The posterior ramus of the sub-occipital nerve does not divide into medial and lateral divisions. It enters the sub-occipital triangle by passing dorsally, between the posterior arch of the atlas and the vertebral artery, and at once breaks up into branches which go to supply five muscles—viz., the two posterior recti, the two oblique muscles, and the semispinalis capitis. In addition to the muscular twigs it gives a *communicating*, and sometimes a *cutaneous filament.*

The *communicating branch* generally proceeds from the nerve to the obliquus capitis inferior, and joins the greater occipital nerve. The *cutaneous branch*, when present, accompanies the occipital artery to the integument over the occiput.

Arteria Vertebralis. — Only the third portion of the vertebral artery lies in the sub-occipital triangle. It emerges from the foramen in the transverse process of the atlas, and runs backwards and medially in the groove upon the posterior arch of that bone. As it passes medially it lies immediately posterior to the lateral mass of the atlas and above the sub-occipital nerve. It leaves the space by passing anterior to the thickened lateral extension of the posterior atlanto-occipital membrane, which runs from the posterior arch of the atlas to the posterior lip of its articular process and is called the oblique ligament of the atlas; then the artery pierces the dura mater and enters the spinal canal (Fig. 37).

Small branches proceed from the vertebral artery, as it lies in the sub-occipital space, to supply the parts in its immediate neighbourhood, and to anastomose with the descending branch of the occipital artery and the arteria profunda cervicis.

Dissection to open the Vertebral Canal.—The first step consists in thoroughly cleaning the laminæ and spinous processes upon both sides. The multifidus must be completely removed from the dorsum of the sacrum. At the same time the posterior rami of the nerves must be retained, so that their continuity with the various spinal nerve-trunks may be afterwards established. The dissector should then remove the posterior wall of the vertebral canal *in one piece* by sawing through the laminæ on each side, and dividing the ligamenta flava, from the third cervical vertebra down to the lower opening of the sacral canal.

In making this dissection the student must attend to the following points :—(1) the cut should be directed through the laminæ close to the medial sides of the articular processes; (2) the saw must be used in an oblique plane, so that the cut through the laminæ slants slightly medialwards; (3) as the cervical laminæ are cut through, the head and neck should hang over the end of the table, and be flexed as much as possible, whilst the saw is worked from below upwards; (4) in the case of the lumbar region, where, indeed, most difficulty will be met, a high block must be placed under the abdomen of the subject, whilst the blocks supporting the chest and pelvis are removed. It will probably be necessary at this point to have recourse to the hammer and chisel.

The laminæ and spinous processes which are thus removed are connected with each other by the ligamenta flava and the supraspinous and interspinous ligaments. They should be laid aside for the present. A description of the ligaments will be found on p. 269. Whilst the specimen is fresh, however, the dissector should test the high elasticity of the ligamenta flava by stretching them.

Between the dura mater and the walls of the canal, the dissector will notice a quantity of loose areolar tissue and soft fat. The latter is especially plentiful in the sacral region, where it somewhat resembles the marrow in the medullary cavity of a long bone. Great numbers of large veins and minute arteries ramify in this areolo-fatty material.

Arteriæ Spinales.—In a well injected subject a minute spinal artery will be seen entering the vertebral canal through each intervertebral foramen. These arteries are derived from different sources in the different regions of the vertebral column. In the cervical region they come from the vertebral artery; in the thoracic region, from the posterior branches of the intercostal arteries; in the lumbar region, from the dorsal branches of the lumbar arteries. They supply the spinal medulla and its meninges, the bones, the periosteum, and the ligaments; and their arrangement is very much the same in each of the three regions.

Each spinal artery may be looked upon as giving off *three main twigs*; one of them, termed the *pre-laminar branch*, is a very small twig which ramifies upon the deep surface of the vertebral arches and ligamenta flava. Another, the *neural branch*, can be followed to the dura mater, which it pierces immediately above the point of exit of the corresponding spinal nerve. It divides into two twigs, one of which passes along the posterior and the other along the anterior root of the nerve to join the plexus in the spinal pia mater. The third, the *post-central branch*, is carried medially, anterior to the dura mater, towards the posterior surface of the vertebral bodies; it divides into an ascending and a descending twig which anastomose with the corresponding twigs above and below, and in that manner a continuous series of minute arterial arcades is formed, from which branches pass medially to form a series of cross anastomoses with the corresponding vessels of the opposite side.

In the *cervical region* small branches from the ascending cervical artery also find their way into the vertebral canal; whilst in the *sacral portion* of the canal the dissector will find branches from the lateral sacral arteries.

Internal Vertebral Venous Plexus.—The internal vertebral venous plexus extends along the whole length of the vertebral canal, and consists essentially of four subsidiary longitudinal plexuses, two anterior and two posterior, which anastomose freely with each other.

The *posterior plexuses* are united by many cross branches, which run along the deep aspect of the vertebral arches and ligamenta flava. Above, they communicate with the occipital sinus, whilst, all the way down, they are connected with the *posterior vertebral venous plexus* by wide channels which pierce the ligamenta flava. Laterally, they send branches through the intervertebral foramina to join the posterior branches of the intercostal and lumbar veins.

The *anterior plexuses* cannot be dissected whilst the medulla spinalis

(O. T. spinal cord) and its membranes are *in situ*, but it is convenient to describe them at this stage. Indeed, the dissection is one of considerable difficulty, even under the most advantageous circumstances. They form two main longitudinal venous channels, placed one upon each side of the posterior longitudinal ligament of the vertebral bodies, and they are joined by transverse branches which cross the median plane, anterior to that ligament, opposite each vertebral body. Each transverse vein receives large tributaries from the interior of the vertebra. Superiorly, each of the main longitudinal channels communicates with the occipital sinus or the basilar plexus, within the cranium; and each of the posterior channels gives off a branch which emerges above the posterior arch of the atlas to join the commencement of the vertebral vein. Opposite the various intervertebral fibro-cartilages the anterior plexus sends off branches which run towards the intervertebral foramina, where they join with corresponding branches of the posterior plexus, to form the intervertebral veins which accompany the corresponding spinal nerves.

Meninges of the Medulla Spinalis (Fig. 21).—The medulla spinalis, like the brain, with which it is continuous, is enveloped by three membranes, termed *meninges*. The most external investment is a strong fibrous membrane called the *dura mater*; the second, in order from without inwards, is a non-vascular tunic termed the *arachnoid*; whilst the third and most internal is the *pia mater*. The three membranes are directly continuous with the corresponding investments of the brain.

> ***Dissection.***—**The outer surface of the dura mater must now be cleaned. This is effected by the removal of the loose areolar tissue, soft fat, and posterior internal vertebral from the vertebral canal. It is necessary, also, to define carefully the numerous lateral prolongations which the membrane gives to the spinal nerves.**

Dura Mater Spinalis (Fig. 21).—In the vertebral canal the dura mater constitutes an exceedingly dense and tough fibrous tube, which extends from the foramen magnum above, to the level of the second or third piece of the sacrum below. It is separated from the walls of the vertebral canal and its lining periosteum by an interval which is filled with loose fat and areolar tissue and the internal vertebral venous plexus. Even before the membranous tube is laid open, the dissector can readily satisfy himself that it forms a very loose sheath around the spinal medulla and the nerve-roots which form the cauda equina below the spinal medulla; in other words, it is very capacious in comparison with the volume of its contents. Its calibre, moreover, is by no means uniform; in the cervical and lumbar regions it is considerably wider than in the thoracic region, whilst in the sacral canal it rapidly contracts and finally ends, at the level of the second sacral vertebra, by blending with the *filum terminale*, a fibrous thread which is prolonged downwards through the sacral canal from the extremity of the medulla spinalis (O.T. spinal cord).

The cylindrical tube of spinal dura mater does not lie free within the vertebral canal, but its attachments do not in any way interfere with the free movement of

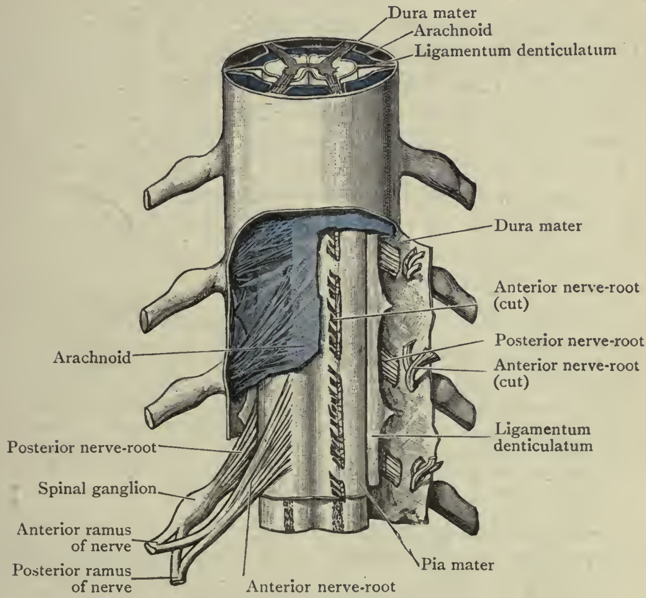


FIG. 21.—Membranes of the Medulla Spinalis (O.T. Spinal Cord), and the mode of origin of the Spinal Nerves.

the vertebral column. *Above*, the dura mater is firmly attached around the margin of the foramen magnum, and to the bodies of the second and third cervical vertebræ; *below*, the filum terminale, on which the dura mater terminates, can be traced as far as the dorsum of the coccyx, where it is lost by blending with the periosteum. On each side, the spinal nerve-roots, as they pierce the dura mater, carry with them, into the intervertebral foramina, tubular sheaths of the membrane, which are attached to the margins of the foramina; whilst, anteriorly, loose fibrous prolongations—more numerous above and below than in the thoracic region—connect the tube of dura mater to the posterior longitudinal ligament of the vertebral column. No connection of any kind exists between the dura mater and the vertebral arches or ligamenta flava.

***Dissection.*—The tube of dura mater may now be opened with the scissors. The incision should be carried through the membrane in the median plane. Care, however, must be taken not to injure the delicate arachnoid, which is subjacent.**

Cavum Subdurale.—The subdural cavity is the capillary interval between the dura mater and the arachnoid (Fig. 20). The deep surface of the dura, which is turned towards the space, is smooth, moist and polished. The dissector will notice, upon each side, the series of apertures of exit for the roots of the spinal nerves. They are ranged in pairs opposite each intervertebral foramen. The subdural space is prolonged laterally, for a short distance, upon each of the nerve-roots, and has a free communication with the lymph paths present in the nerves.

Viewed from the inside of the tube of dura mater, each of the two nerve-roots belonging to a spinal nerve is seen to carry with it a special and distinct sheath. When examined, however, on the outside of the tube of dura mater, they appear to be enveloped in one sheath, because the two sheaths are closely held together, on the outside, by intervening connective tissue which can be removed with a little careful dissection. When that is done, the two tubular sheaths will be seen to remain distinct as far as the ganglion on the posterior root of the nerve. At that point they blend with each other.

Arachnoidea Spinalis (Fig. 20).—The arachnoid, like the dura mater, forms a loose, wide investment for the spinal medulla. Unlike the dura, however, it is remarkable for its great delicacy and transparency. The sac is most capacious, and can be demonstrated most easily towards its lower part, where it envelops the extremity of the spinal medulla and the collection of long nerve-roots which constitute the *cauda equina*. Make an incision into it, and insert the handle of the scalpel, or, better still, inflate the sac with air by means of a blowpipe. Above, the spinal arachnoid becomes continuous, through the foramen magnum, with the arachnoid membrane of the brain. On each side, it is prolonged upon the various nerve-roots, contributing a tubular sheath to each. It ends, below, at the level of the second sacral vertebra, by fusing with the filum terminale.

Cavum Subarachnoideale (Fig. 20).—The sub-arachnoid cavity is the wide space between the arachnoid and pia mater. It is occupied by a variable amount of cerebro-spinal fluid, and is directly continuous with the cranial sub-arachnoid space through the foramen magnum. Three incomplete septa partially subdivide the spinal sub-arachnoid space into compartments. One of the septa is a median partition, called the *septum subarachnoideale*, which connects the arachnoid with the pia mater covering the posterior aspect of the spinal medulla. In the upper part of the cervical region the sub-arachnoid septum is represented merely by a number of strands passing between the two membranes; in the lower part of the cervical region and in the thoracic region it is almost complete. The other two septa are the ligamenta denticulata. They spread laterally, one from each side of the medulla spinalis, and will be studied with the pia mater.

***Dissection.*—Take away the arachnoid from a portion of the spina medulla, and proceed to the study of the pia mater.**

Pia Mater Spinalis.—The pia mater of the spinal medulla is a firm vascular membrane, which adheres closely to the surface of the medulla spinalis (O.T. spinal cord). It is thicker and denser than the pia mater of the brain, largely owing to the addition of an outer layer of fibres, which run chiefly in a longitudinal direction. It is folded into the antero-median fissure of the medulla spinalis; and the posterior median septum of the medulla spinalis is firmly attached to its deep surface. Anteriorly, in the median plane, it is thickened to form a longitudinal glistening band, which receives the name of the *linea splendens*. Of course, that can be seen only after the medulla spinalis has been removed from the vertebral canal. The blood vessels of the medulla spinalis lie between the two layers of the pia mater before they enter the substance of the spinal medulla; and the various spinal nerves receive from it closely fitting sheaths which blend with their connective-tissue coverings.

Ligamentum Denticulatum (Figs. 20 and 22).—There are two dentate ligaments, one on each side. Each stretches laterally from the corresponding side of the medulla spinalis and connects it with the dura mater. Its *medial attachment* extends in a continuous line, between the anterior and posterior nerve-roots, from the level of foramen magnum, above, to the level of the body of the first lumbar vertebra, below. Its *lateral margin* is widely serrated or denticulated. From twenty to twenty-two denticulations may be recognised; the highest is attached to the margin of the foramen magnum. They occur in the intervals between the spinal nerves, and, pushing the arachnoid before them, they are attached by their pointed extremities to the inner surface of the dura mater.

The ligamenta denticulata maintain the medulla spinalis (O.T. spinal cord) in the middle of the tube of dura mater, and partially subdivide the sub-arachnoid space into an anterior and a posterior compartment. In the anterior compartment the anterior nerve-roots pass laterally; the posterior compartment contains the posterior nerve-roots, and is imperfectly subdivided into two lateral subdivisions by the septum subarachnoideale.

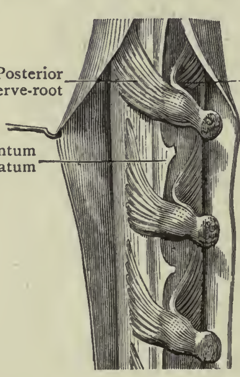


FIG. 22.—Lateral view of the Medulla Spinalis, Dura Mater, and Ligamentum Denticulatum. (Hirschfeld and Leveillé.)

Medulla Spinalis (O.T. **Spinal Cord**).—The spinal medulla itself may now be studied *in situ*. It is almost cylindrical in form but is slightly flattened anteriorly and posteriorly. It extends from the foramen magnum, where it is continuous with the medulla oblongata of the brain, to the lower border of the body of the first or the upper border of the body of the second lumbar vertebra. Its lower end rapidly tapers to a point, and is termed the *conus medullaris*. From the extremity of the conus a slender filament, termed the *filum terminale*, is prolonged downwards to the dorsal surface of the coccyx.

In the female the average length of the medulla spinalis is 43 cm.; in the male it is 45 cm. (18 *inches*).

Throughout the greater part of the thoracic region, the medulla spinalis presents a uniform girth, but in the cervical and lower thoracic regions it shows marked swellings, termed respectively the *intumescentia cervicalis* and *intumescentia lumbalis.* The *cervical enlargement*, which is connected with the nerves of the superior extremities, is the more evident of the two. It begins at the upper end of the medulla spinalis (O.T. spinal cord), attains its greatest breadth (13 or 14 mm.) opposite the fifth or sixth cervical vertebra, and subsides opposite the second thoracic vertebra. The *lumbar enlargement* is connected with the nerves of the inferior extremities. It begins at the level of the tenth thoracic vertebra, attains its maximum transverse diameter (11 to 13 mm.) opposite the last thoracic vertebra, then it rapidly tapers into the conus medullaris.

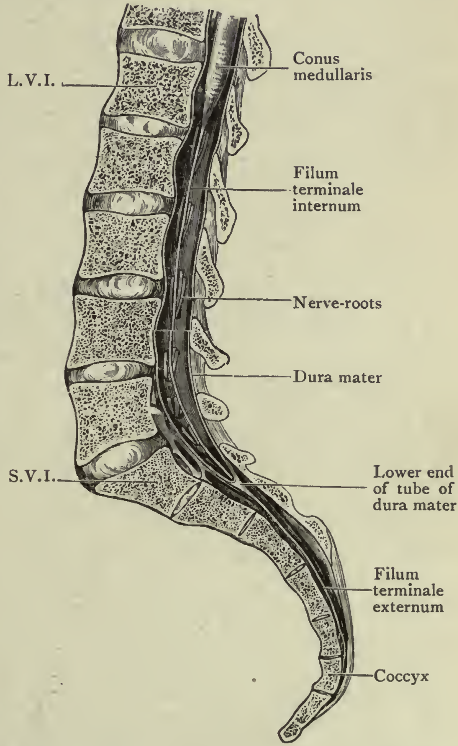


FIG. 23.—Sagittal section through the lower part of the Vertebral Canal.

Filum Terminale. — The delicate thread-like terminal filament lies amidst the numerous long nerve-roots which occupy the lower part of the vertebral canal, but it can readily be distinguished from them (1) by its silvery glistening appearance, and (2) by its continuity with the extremity of the *conus medullaris* (Fig. 23).

It is composed chiefly of pia mater, although the central canal of the medulla spinalis is prolonged down in its interior for nearly half its length, and nervous elements can be traced in its substance for a like distance. The *linea splendens* and the lower ends of the *ligamenta denticulata* may also be considered to be continued into it. At the level of the second or third sacral vertebra it pierces the tapered end of the tube of dura mater, and receives an investment from it; finally it reaches the lower end of the sacral canal, where it terminates by blending with the periosteum on the dorsal surface of the coccyx or the last piece of the sacrum.

In length it measures about 15 cm. (6 *inches*). The part within the tube of dura is termed the *filum terminale internum*, the portion outside is the *filum terminale externum*.

Nervi Spinales.—Thirty-one spinal nerves take origin from each side of the medulla spinalis (O.T. spinal cord). They are classified into five groups, according to the vertebræ with which they are associated. The thoracic, lumbar, and sacral nerves correspond in number with the vertebræ in each of those regions—thus, there are twelve thoracic, five lumbar, and five sacral nerves, each of which issues from the vertebral canal below the vertebra with which it numerically corresponds. In the cervical region, however, there are eight nerves. The first of them comes out between the occiput and the atlas, and is therefore distinguished by the special name of the *sub-occipital nerve.* There is only one coccygeal nerve on each side.

Spinal Nerve-Roots (Figs. 21 and 24).—Each spinal nerve springs from the side of the spinal medulla by *two roots*—an *anterior* and a *posterior*. Except in the case of the sub-occipital nerve (where the posterior root is sometimes absent), the posterior nerve-root is the larger of the two. In addition, the posterior root is distinguished by possessing an oval ganglion, termed the *spinal ganglion.* There is, also, a wide physiological difference between the two roots—the posterior root is composed of afferent fibres; the anterior root consists of efferent fibres. Immediately beyond the ganglion the two roots unite to form the *spinal nerve-trunk*, which contains a mixture of both efferent and afferent nerve-fibres.

The *mode of attachment* of the two nerve-roots to the side of the medulla spinalis is somewhat different in the two cases. In each instance they are attached by several separate *fila radicularia*, which spread out from each other as they approach their attachments. In the case of the posterior root the fila enter the spinal medulla consecutively, along a continuous straight line and at the bottom of a slight furrow. The fila of the anterior root, on the other hand, are not so regularly placed. They emerge from the medulla spinalis over an area of some breadth. The portion of the medulla spinalis which stands in connection with a pair of nerves receives the name of a "neural segment."

It will be noted that the *size* of the nerve-roots differs greatly. The lower lumbar and upper sacral nerve-roots are much the largest, whilst the lower sacral and the coccygeal roots are the smallest. In the cervical region the roots increase in size from above downwards, but more rapidly in the lower members of the group; in the thoracic region the roots of the

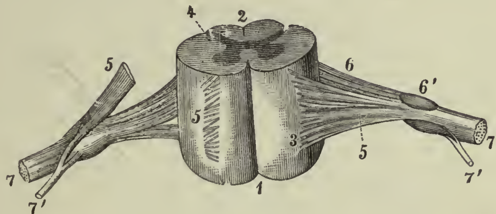


FIG. 24.—A segment of the Medulla Spinalis; anterior aspect. (Schwalbe, after Allen Thomson.)

1. Anterior median fissure.
2. Posterior median sulcus.
3 and 5. Fila of anterior nerve-root.
4. Posterior lateral groove.
6. Posterior nerve-root.
6′. Spinal ganglion.
7. Anterior ramus.
7′. Posterior ramus.

first nerve are large, but those which succeed it are small and of uniform size.

In *relative length*, and in the *direction* which they follow in the vertebral canal, the nerve-roots also show great differences. The differences are due to the medulla spinalis being so much shorter than the canal in which it lies. In the upper part of the cervical region the nerve-roots are short, and proceed laterally and almost horizontally. Below the upper cervical region the nerve-roots become more oblique, and the lower the origin of the nerve the longer is its course in the canal. The arrangement of the lower thoracic, the lumbar, sacral, and coccygeal nerve-roots is particularly characteristic. They are exceedingly long, and descend vertically from the lower portion of the medulla spinalis, forming the bundle which is called the *cauda equina*.

The origins of the eight cervical nerves lie between the level of the atlas and the level of the spine of the sixth cervical vertebra; the origins of the first six thoracic nerves extend from the sixth cervical to the third thoracic spine; the origins of the lower six thoracic nerves lie between the third and the ninth thoracic spines; and the origins of the lumbar and sacral nerves are between the ninth thoracic and the first lumbar spine.

Mode of Exit of Spinal Nerves from Vertebral Canal.—The lower six cervical nerves, the thoracic nerves, and the lumbar nerves make their exit through the intervertebral foramina; whilst each of the two rami of the upper four sacral nerves finds its way out by a sacral foramen. The upper two cervical nerves, the fifth sacral nerve, and the coccygeal nerve, however, follow a different course. The sub-occipital emerges by passing over the posterior arch of the atlas, and the second cervical nerve by passing over the vertebral arch of the epistropheus (O.T. axis). The fifth sacral and the coccygeal nerve leave the sacral canal through its lower aperture (Fig. 25).

Dissection.—The nerve-roots of one or two spinal nerves in each region should be followed into the corresponding intervertebral foramina. That can be easily done by snipping away the articular processes with the bone-forceps. The position of the ganglion on the posterior root, the connections of the sheath of dura mater, the union of the two roots to form the spinal nerve-trunk, and the division of the trunk into the anterior and posterior rami can then be studied. An attempt should also be made, at the same time, to discover the minute *ramus meningeus*. It is a fine twig which is formed by the union of a small filament from the spinal nerve-trunk with a minute branch from the sympathetic trunk. It takes a recurrent course through the intervertebral foramen to end in the bones and periosteum and meninges of the vertebral canal.

Ganglia Spinalia.—The spinal ganglia are oval swellings developed upon the posterior nerve-roots, just before they unite with the anterior roots to form the spinal nerve-trunks. They are found upon the posterior roots of all the nerves, except, occasionally, those of the sub-occipital and the coccygeal nerves.

The ganglia are formed upon the posterior nerve-roots as they lie in the intervertebral foramina, except in the cases of the first two cervical and the sacral and coccygeal nerves. The ganglia of the first two cervical nerves lie upon the posterior arch of the first and the vertebral arch of the second cervical vertebræ, respectively; the ganglia of the sacral nerves are placed within the sacral canal, but outside the tube of dura mater. The ganglion on the posterior root of the coccygeal nerve is inside the tube of dura mater.

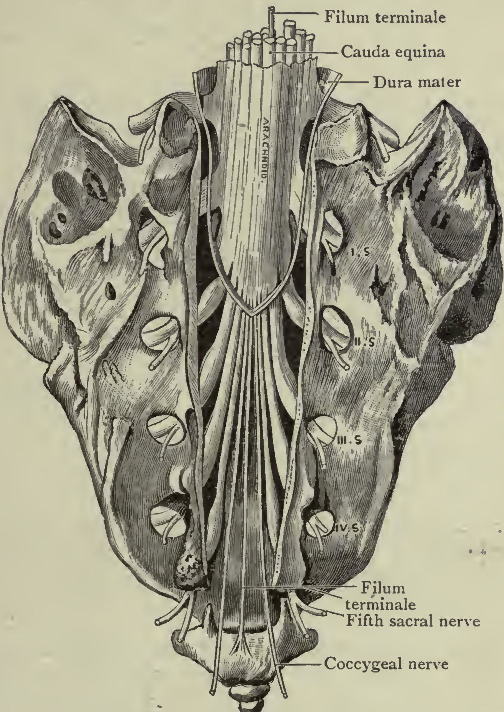


FIG. 25.—The Sacral Nerve-roots (lower part of Cauda Equina) and the Membranes in relation to them. (After Testut.) The posterior wall of Sacral Canal has been removed.

Spinal Nerve-Trunks.—The trunks of the spinal nerves are formed by the union of the anterior and posterior nerve-roots immediately beyond the spinal ganglia. The union takes place in the case of the coccygeal and sacral nerves in the sacral canal; in the lumbar, thoracic, and lower six cervical nerves, in the intervertebral foramina; and in the case of the first two cervical nerves, on the arches of the atlas and epistropheus respectively.

The nerve-trunk is exceedingly short in most cases; indeed, it divides almost immediately into its *anterior* and *posterior rami*. In the cases of the sacral and coccygeal nerves, the subdivision takes place in the sacral canal, and the spinal nerve-trunks of those nerves are distinctly longer than the trunks of the nerves which occupy a higher level.

The distribution of the posterior rami has already been examined (p. 69).

Dissection.—At this stage the dissector may adopt one of two methods in the further treatment of the medulla spinalis and the nerves which spring from it. If the medulla spinalis is fresh and in such a condition that it may be successfully hardened, it is best to transfer it at once to the preservative fluid. If, on the other hand, it is soft and not fit for proper preservation, it should be removed with all its membranes and nerve-roots, and placed in a cork-lined tray filled with water. There is no method by which the arachnoid, the pia mater, the ligamenta denticulata, and the nerve-roots can be so well studied as this.

To remove the medulla spinalis, the dissector should divide the spinal nerves as they lie in the intervertebral foramina, and in such a manner that as long a piece as possible of each nerve remains attached to the dura mater and the spinal medulla. Wherever it is possible the ganglia should be taken with the nerves. The same rule applies to the sacral nerves also. The medulla spinalis and its membranes should then be cut across at the highest limit of the vertebral dissection. Pull upon the dura mater in order to lift the whole specimen from the vertebral canal, and then transfer it to the water-bath. Slit up the dura mater along the median plane anteriorly, and turn aside the edges of the incision. By fixing the dura mater with pins to the cork at the bottom of the tray, the dissector can conduct the further dissection with great advantage, and can display in turn the arachnoid, and the pia mater with the ligamenta denticulata.

Arteries of the Medulla Spinalis (O.T. **Spinal Cord**).—It is only when the arterial injection is particularly good that the spinal arteries can be made out satisfactorily.

Numerous small arteries are supplied to the medulla spinalis. They are the *anterior* and *posterior spinal arteries*, which spring from the vertebral artery in the cranium, and a series of *lateral spinal arteries*, which reach the side of the medulla spinalis and are derived from different sources in each region. *In the neck* they come from the vertebral, ascending cervical, and deep cervical arteries; and *in the thoracic* and *lumbar regions*, from the posterior branches of the intercostal and lumbar arteries. By the anastomoses of the various arterial twigs, five longitudinal trunks are formed upon the surface of the medulla spinalis. One lies in the median plane anteriorly, and may be termed the *antero-median artery.* The other four are placed in relation to the sulci along which the posterior nerve-roots enter the medulla spinalis. One runs downwards anterior to the line of entrance of those roots, and the other posterior to it, on each side of the medulla spinalis. The posterior vessels may, therefore, be termed the *postero-lateral longitudinal vessels.*

The *antero-median vessel* is formed above by the union of the two anterior spinal branches of the vertebral arteries. One of them is larger than the other, and takes a much greater share in the formation of the median trunk. Below the level of the fifth pair of cervical nerves the continuity of the median vessel depends upon the reinforcements which it obtains from the lateral spinal vessels. The number of lateral spinal arteries which join the median vessel is very variable. The majority of them end on the nerve-roots; only five to ten reach the median vessel. The *antero-median artery* runs downwards, under cover of the linea splendens of the pia mater. Its calibre is uniform throughout, and where the medulla spinalis ends it proceeds onwards for some distance upon the filum terminale.

The *postero-lateral arteries* on each side of the medulla spinalis are formed in the upper part of the cervical region by the bifurcation of the corresponding posterior spinal branch of the vertebral artery. Lower down their continuity is maintained by twigs which reach them, on the posterior roots of the spinal nerves, from the lateral spinal arteries. It may be regarded as a rule, that where a lateral spinal artery gives a branch to one of the postero-lateral arterial trunks, it does not furnish another to the antero-median arterial trunk. Nevertheless, the different lateral spinal arteries are in connection, directly or indirectly, with the longitudinal trunks on the anterior and posterior aspects of the medulla spinalis. The postero-lateral vessels end at the lower extremity of the medulla spinalis.

From the five main arterial channels which thus extend along the spinal medulla spring numerous anastomosing twigs which ramify in the pia mater.

Veins of the Medulla Spinalis.—The veins of the spinal medulla are small and numerous, and their disposition cannot be said to correspond with that of the arteries. They are very tortuous, and form a plexus with elongated meshes. Six more or less perfect longitudinal venous trunks may be noticed on the surface of the medulla spinalis in connection with the venous plexus; two of them are median, and are placed respectively on the anterior and posterior aspects. The anterior trunk runs upwards under cover of the antero-median spinal artery. The other four are lateral, and are situated two on each side, in relation, respectively, to the anterior and posterior nerve-roots.

Upon each side, the veins of the medulla spinalis effect communications with the veins in the vertebral canal by means of small twigs which run laterally on the nerve-roots.

How to distinguish the anterior from the posterior surface of the medulla spinalis.

Anterior Surface.	Posterior Surface.
1. Linea splendens.	1. The postero-lateral arteries, in relation to the posterior nerve-roots.
2. Single anterior spinal artery, in median plane.	2. Fila of origin of posterior nerve-roots entering the medulla spinalis along a straight and continuous line, and at the bottom of a distinct sulcus.
3. Anterior nerve-roots, smaller than posterior, and springing by fila which emerge from the medulla spinalis, not in a continuous straight line, but irregularly over an area of some width.	3. Posterior nerve-roots, larger than the anterior, and provided with ganglia.

Preservation of the Medulla Spinalis.—If the medulla spinalis is in a fit state for preservation, it should be immersed for a few weeks in methylated spirit, to which a small amount (4 per cent.) of formalin has been added. When sufficiently firm, the dissector should endeavour to learn something of its internal structure by making transverse sections across it at different levels, and inspecting the cut surface closely with the naked eye, or with the aid of a magnifying glass.

Internal Structure of the Medulla Spinalis.—The medulla spinalis is composed of an inside core of grey matter which is surrounded on all sides by an external coating of white matter, and a good deal can be learned by a naked-eye inspection of cross sections through it made in different regions and at different levels.

In such sections the *antero-median fissure* and the *postero-median septum* and *sulcus*, which partially divide it along the whole of its length into right and left halves, become obvious.

The antero-median fissure is much shorter than the postero-median septum. It dips dorsally to a commissure of white matter, the *anterior white commissure*, which connects the white matter of the two halves of the medulla spinalis; and it contains a fold of pia mater and branches of the anterior spinal vessels. The postero-median sulcus is a shallow furrow which runs along the posterior surface of the medulla spinalis in the median plane, and the postero-median septum extends from the bottom of the sulcus to a transverse grey commissure called the *posterior commissure*, which connects the two halves of grey matter.

The two halves of the medulla spinalis, thus marked off from each other, are to all intents and purposes symmetrical, and they are joined by a more or less broad band or commissure which intervenes between the anterior fissure and the posterior septum.

An inspection of the surface of each half of the medulla spinalis brings into view a groove or furrow at some little distance from the postero-median sulcus; it is called the *postero-lateral sulcus.* Along the bottom of that groove the fila of the posterior nerve-roots enter the medulla spinalis (O.T. spinal cord) in accurate linear order. There is no

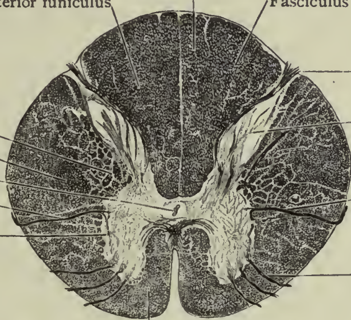


FIG. 26.—Transverse section through the upper part of the Cervical Region of the Medulla Spinalis.

corresponding furrow on the anterior part of each half of the medulla spinalis in connection with the emergence of the fila of the anterior nerve-roots; and it should be noted that the anterior root fila emerge over a relatively broad area, which corresponds in its width to the thickness of the subjacent anterior column of grey matter (Fig. 26).

Grey Matter of the Medulla Spinalis.—The grey matter in the interior of the medulla spinalis has the form of a fluted column. When seen in transverse section, it presents the shape of the letter H. In each half of the medulla spinalis there is a mass of grey matter, comma-shaped in section with the concavity directed laterally. The grey columns of opposite sides are connected across the median plane by a transverse band, which is called the *grey commissure.* The postero-median septum passes from the surface of the medulla spinalis to the grey commissure. The bottom of the antero-median fissure is separated from the grey commissure by an intervening strip of white matter which is termed the *anterior white commissure.* In the grey commissure may be seen the central canal of the spinal medulla. It is just visible to the naked eye as a minute speck. The canal tunnels the entire length of the spinal medulla, and opens above (after having traversed the lower half of the medulla oblongata) into the fourth ventricle of the brain. The portion of the grey commissure which lies posterior to the central canal is called the *posterior commissure*; the portion anterior to it receives the name of *anterior grey commissure.*

In each lateral mass of grey matter certain well-defined parts may be recognised. The projecting portions which extend posterior and anterior to the connecting transverse grey commissure are termed the *posterior* and the *anterior grey columns.* They can be distinguished from each other at a glance.

The *anterior grey column* is short, thick, and its anterior margin is very blunt. Further, its anterior margin is separated from the surface by a moderately thick coating of white matter, through which the fila of the anterior nerve-roots pass on their way to the surface. The thickened anterior margin of the anterior column is termed its *head*, and the constricted part close to the grey commissure is called the *neck.* The *posterior grey column*, in most localities, is narrow. Further, it is drawn out to a fine edge, which almost reaches the bottom of the postero-lateral sulcus. This sharp edge receives the name of the *apex of the posterior column*; the slightly swollen part which succeeds it is the *head of the posterior column*; whilst the slightly constricted part adjoining the grey commissure goes under the name of the *neck of the posterior column.*

Covering the edge of the posterior column there is a substance which differs in its composition from the general mass of grey matter, and presents a translucent appearance. It is termed the *substantia gelatinosa* (*Rolandi*).

The grey matter is not present in equal quantity throughout the entire length of the medulla spinalis. Therefore it is necessary that it should be considered in different regions; and it must be understood, when the terms cervical, lumbar, sacral, etc. are applied to different portions of the spinal medulla, that those terms apply to the regions to which the nerves of the same name are attached.

Wherever there is an increase in the size of the nerves attached to a particular part of the medulla spinalis, there a corresponding increase of the grey matter may be noticed. It follows that the districts in which the grey matter bulks most largely are the lumbar and cervical enlargements. The great nerves which go to form the limb plexuses enter and pass out from those portions of the medulla spinalis. In the intervening thoracic region there is a reduction in the quantity of grey matter, in correspondence with the smaller size of the thoracic nerves.

The shape of the columns of grey matter, in section, is not the same in all regions. In the thoracic region both columns are narrow, although the distinction between the anterior grey column and the more attenuated posterior grey column is still sufficiently manifest. In the cervical region the contrast between the grey columns is most marked; the anterior grey column is very thick in comparison with the posterior grey column. In the lumbar region, on the other hand, the difference in the thickness of the two grey columns is not nearly so apparent, owing to a broadening out of the posterior grey column. A section taken from the centre of each region can very readily be recognised by the features mentioned (Fig. 27).

In the thoracic region of the spinal medulla, more especially in the upper part, there is another character which is very distinctive. A pointed and prominent triangular projection juts out from the lateral aspect of the crescentic mass of grey matter, nearly opposite the grey commissure. It is called the *lateral grey column* (Fig. 27, B and C). It disappears in the cervical and lumbar enlargements generally, but again becomes evident both in the upper cervical and in the lower sacral regions.

Below the thoracic region the postero-median septum diminishes and the antero-median fissure increases in depth, until, in the sacral region, they are almost equal in depth and the central canal occupies the centre of the medulla spinalis.

White Matter of the Medulla Spinalis.—The white matter forms a thick coating on the outside of the fluted column of grey matter. It is marked off into three funiculi. The *posterior funiculus* is wedge-shaped in transverse section,

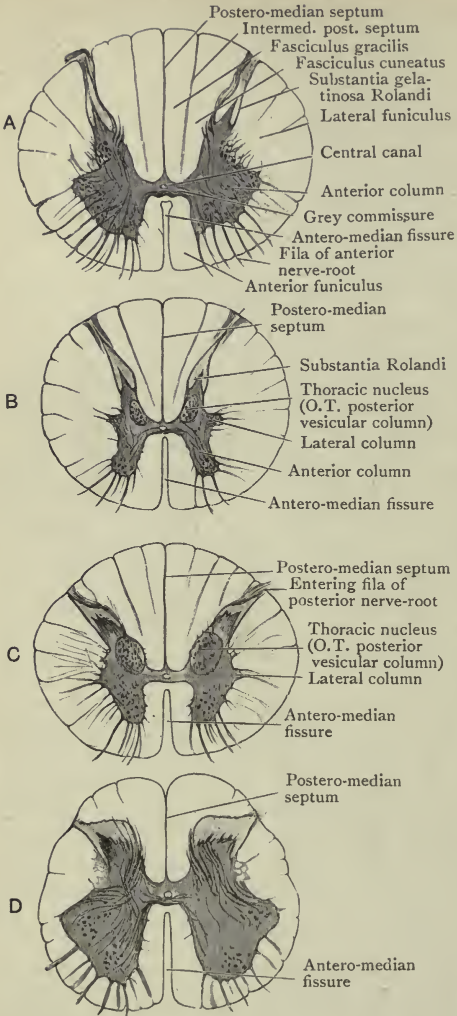


FIG. 27.—Transverse sections through the Medulla Spinalis in different regions. A. Cervical Region; B. Mid-thoracic Region; C. Lower Thoracic Region; D. Lumbar Region.

and lies between the postero-median septum and the posterior grey column. The *lateral funiculus* occupies the concavity of the grey crescent. Posteriorly, it is bounded by the posterior grey column and the postero-lateral sulcus, whilst, anteriorly, it extends as far as the most lateral fila of the anterior nerve-roots. The *anterior funiculus* includes the white matter between the antero-median fissure and the anterior column of grey matter, and also the white matter which separates the thick margin of the anterior grey column from the surface of the spinal medulla and is traversed by the emerging fila of the anterior nerve-roots (Figs. 26, 27).

In the cervical region a faint longitudinal groove runs downwards on the surface of the posterior funiculus of the medulla spinalis. It indicates the position of a septum which passes into the funiculus from the deep surface of the pia mater and divides it incompletely into two unequal strands. The groove is termed the *intermediate posterior sulcus.* The strand on its medial side is the *fasciculus gracilis* (Goll's), whilst the lateral and larger strand receives the name of the *fasciculus cuneatus* (Burdach's).

The white matter of the medulla spinalis increases steadily in quantity from below upwards.

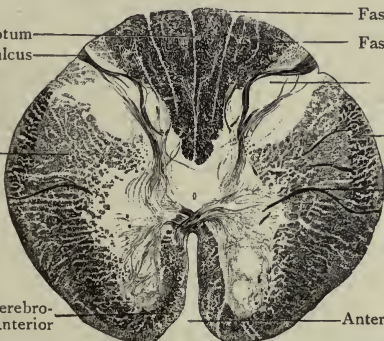


FIG. 28.—Transverse section through the upper cervical part of the Medulla Spinalis of a full-time Fœtus, treated by the Pal-Weigert process.

The fasciculi, gracilis and cuneatus, which form the posterior funiculus of the medulla spinalis, are composed of fibres which enter the spinal medulla as the fila of the posterior nerve-roots. In the lower portion of the medulla spinalis the two fasciculi are not marked off from each other.

In the lateral and anterior funiculi of the adult spinal medulla it is not possible with the naked eye to distinguish the different strands of fibres of which they consist, but the student should remember that such strands or tracts are present. The three best-defined tracts in the antero-lateral part of the spinal medulla are, (1) the fasciculus spino-cerebellaris (O.T. direct cerebellar tract); (2) the fasciculus cerebro-spinalis lateralis (O.T. crossed pyramidal tract); (3) the fasciculus cerebro-spinalis anterior (O.T. direct pyramidal tract).

The *fasciculus spino-cerebellaris* ascends to the cerebellum in the postero-lateral part of the lateral funiculus. Traced in the opposite direction, it is found to disappear in the lower thoracic region of the medulla spinalis. The *fasciculus cerebro-spinalis lateralis* occupies a larger district of the medulla spinalis. It is placed in the lateral funiculus, anterior to the posterior column of grey matter and immediately medial to the fasciculus spino-cerebellaris. As the fasciculus spino-cerebellaris disappears in the lower part of the medulla spinalis the fasciculus cerebro-spinalis lateralis comes to the surface, and it can be traced as low as the fourth sacral nerve. The *fasciculus cerebro-spinalis anterior* forms the narrow strip of the anterior funiculus which lies immediately adjacent to the antero-median fissure. It reaches down to about the middle of the thoracic region of the medulla spinalis and then disappears.

After the body has been five days on its face it will be replaced upon its back, with the thorax and pelvis supported by blocks; and the dissectors of the head and neck should at once proceed to clean the temporal fascia, and afterwards to remove the brain and study the interior of the cranium.

Dissection.—Take away the anterior and superior auricular muscles and remove the thin layer of fascia subjacent to them which descends from the lower border of the galea aponeurotica to the zygomatic arch. When that has been done the strong temporal fascia will be exposed. Note that it is attached above to the temporal ridge and below to the upper border of the zygomatic arch. The details of its connections will be studied at a later period.

REMOVAL OF THE BRAIN.

After the superficial attachments of the temporal fascia have been noted the dissectors of the head and neck should proceed to remove the brain.

Dissection.—The head being supported upon a block, extend the median incision, already made in the galea aponeurotica, to the nasion anteriorly and to the external occipital protuberance posteriorly, and cut through the loose areolar tissue and the pericranium in the same line down to the bone. With the handle of the scalpel, or with a chisel, detach the pericranium from the bone on each side and turn it downwards to the temporal lines, leaving the bone perfectly bare. Note that although the pericranium is not firmly attached over the surface of the various bones of the vault, it is firmly attached along the lines of the cranial sutures by processes that dip in between the bones and separate their edges. Detach the galea aponeurotica and the temporal fascia from the temporal ridge, on each side, with the edge of the knife; then, carrying the edge of the knife forwards and backwards between the temporal muscle and the bone, detach the upper part of the muscle from the skull. When that has been done, each half of the scalp can be turned down over the ear.

The dissectors should next obtain a saw, a chisel, and a mallet, and proceed to remove the skull cap or calvaria. The line along which the saw is to be used may be marked out on the skull by encircling it with a piece of string, and then marking the cranium with a pencil along the line of the string. Anteriorly, the cut should be made fully three-quarters of an inch above the margins of the orbits; posteriorly, it should be carried round at the level of a point midway between the lambda [1] and the external occipital

[1] The term "lambda" signifies the apex of the occipital bone, or the point at which the sagittal and lambdoidal sutures meet.

Hold for this week

protuberance. The saw should be used to divide the outer table of the skull only. When the diploe is reached, the sawdust will become red and moist, and the saw should then be abandoned. The hammer and chisel are now brought into requisition, and by short sharp strokes with these the inner table can readily be split along the line in which the outer table of the cranium is divided. When that has been done, insinuate the hook at the end of the cross-bar of the chisel into the fissure in front, and wrench off the skull-cap.

Dura Mater Encephali.—The brain is clothed by three distinct membranes, which are termed the *meninges*. From without inwards they are—(1) the dura mater; (2) the arachnoid; and (3) the pia mater.

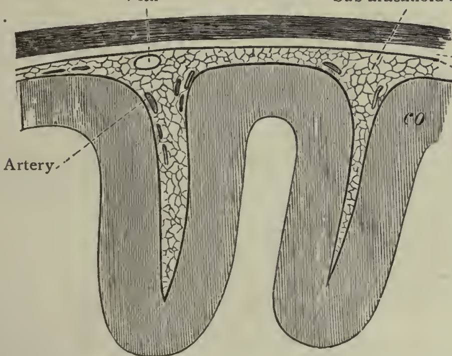


FIG. 29.—Diagrammatic section through the Meninges of the Brain. (Schwalbe.)

co. Grey matter of cerebral gyri.

When the skull-cap is detached, the outer surface of the dura mater, as it covers the upper surface of the cerebral hemispheres, is exposed. It is rough, and dotted over with bleeding points. If a portion is placed in water, its roughness becomes still more manifest, and is seen to be due to a multitude of fine fibrous and vascular processes by which it was connected with the deep surface of the bones. The processes were necessarily torn asunder in the removal of the skull-cap. The bleeding points are most numerous along the median line, or, in other words, along the line of the superior sagittal sinus (O.T. longitudinal); and if the handle of the knife is run from before backwards, so as to make pressure along that line, a considerable quantity of blood will ooze out, showing that a number of small veins from the cranial bones have been ruptured. The degree of adhesion between the dura mater and the inner surface of the cranial bones varies in different subjects and in different localities. In all cases it is strongly adherent along the lines of the sutures, like the pericranium externally; and, further, it is much more firmly attached to the base than to the vault of the cranium. In the child—indeed, as long as the bones of the cranium are growing—it is more adherent than in the adult; and it is more firmly bound to the bone again in old age.

The dissectors should now clean the outer surface of the dura mater with a sponge. They will then recognise the *middle*

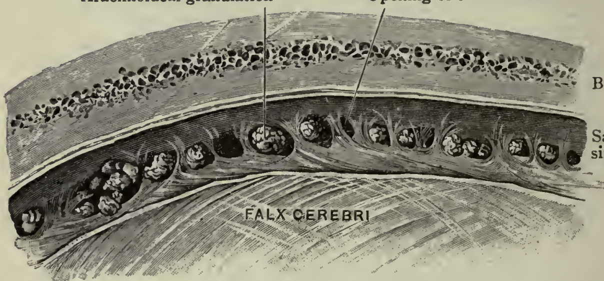


FIG. 30.—Median section through the Frontal Bone and corresponding part of the Superior Sagittal Blood Sinus. The arachnoideal granulations are seen protruding into the sinus. (Enlarged.)

meningeal artery upon each side, ascending in the substance of the outer part of the membrane, and sending off its branches in a widely arborescent manner. It stands out in bold relief from the membrane. If the skull-cap is examined, its inner surface will be observed to be deeply grooved by the artery and its branches, and by the veins which accompany and lie external to them (Wood Jones). The meningeal arteries are not intended for the supply of the membrane alone, as the name might lead one to imagine. They are also the nutrient vessels of the inner table and diploe of the cranial bones (Fig. 32).

Granulationes Arachnoideales (O.T. Pacchionian Bodies).—The arachnoideal granulations are almost invariably present, and, as a rule, are best marked in old subjects. They are small granular bodies, ranged in clusters on each side of the superior sagittal sinus, into which many of them protrude (Fig. 31). As a general rule, they are most evident towards the posterior part of the parietal region. At first sight they appear to be protrusions from the dura mater, but that is not the case. They spring from the arachnoid and the subarachnoid tissue, and are normal enlargements of processes of the arachnoid (Figs. 30, 31).

Two Layers of the Dura Mater.—Having noted the preliminary details from an examination of the outer surface of the dura mater, the student is in a position to understand

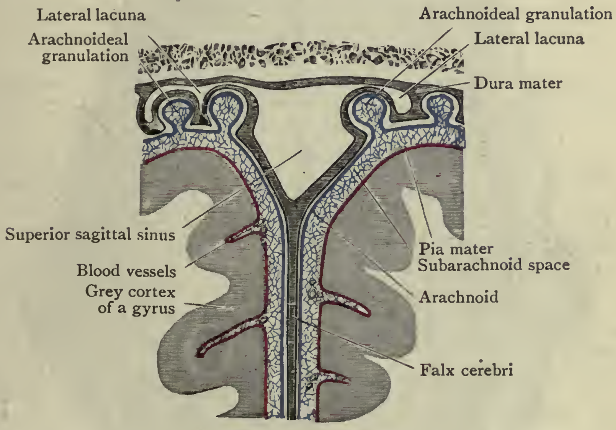


FIG. 31.—Diagram of a frontal section through the middle portion of the cranial vault and subjacent brain to show the membranes of the brain and the arachnoideal granulations.

that the membrane does not belong entirely to the brain. It performs a double function: (1) it acts as an internal periosteum to the bones forming the cranial cavity; and (2) it gives support to the different parts of the brain. Consequently, it consists of two strata, which, in most localities, are firmly adherent, but they can usually be easily demonstrated in the dissecting-room. The two strata may very appropriately be termed the *endocranial* and the *supporting layers*. Along certain lines the two layers separate from each other. In some places they separate to form blood channels, termed *sinuses of the dura mater*, for the passage of venous blood; in other places they separate not only to form blood channels but also that the inner supporting layer may form strong partitions, which pass in between certain parts of the brain ; and by those partitions the cranial cavity is divided into compartments communicating freely with one another, and each holding a definite subdivision of the brain (Figs. 33, 34).

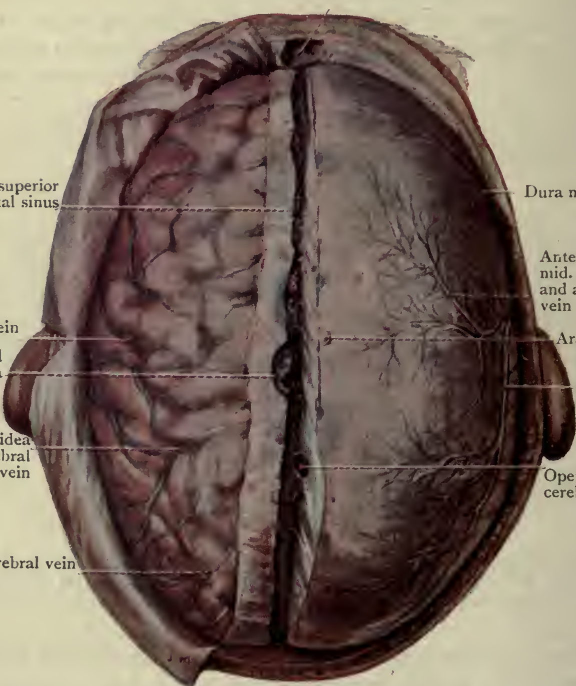


FIG. 32.—Superior Sagittal Sinus ; Dura Mater ; Middle Meningeal Artery and Vein ; Arachnoidea and Superior Cerebral Veins.

Dissection.—The points mentioned must now be verified. Begin by tilting the head forwards. Support it in that position, and make two incisions through the dura mater in an antero-posterior direction—one on each side of the superior sagittal sinus, and along its whole length. From the mid-point of each of the two incisions another cut must be made through the corresponding lateral portion of the dura mater downwards to the cut margin of the skull immediately above the ear (Fig. 32). The dura mater covering the upper aspect of the brain will then be divided into a central strip containing the superior sagittal sinus, and four triangular flaps. The flaps must be turned downwards over the cut margin of the skull, as on the left side in Fig. 32. In that position they cover the sharp edge of the bone and prevent laceration of the brain during its removal.

Cavum Subdurale.—The term subdural space is applied to the interval between the dura mater and the arachnoid—Figs. 29 and 31. It contains a very small quantity of serous fluid, which moistens the opposed surfaces of the membranes. A striking contrast between the two surfaces of the dura mater will be noted. The external surface is rough and flocculent; the internal surface is smooth and glistening.

Venæ Cerebri.—After the dura mater is reflected, the cerebral veins which return the blood from the surface of the cerebral hemispheres can be seen shining through the arachnoid. They are lodged, for the most part, in the sulci between the gyri of the brain, and those at present visible run upwards to the median plane. When they reach the superior sagittal sinus they turn forwards, and lie against the wall of the sinus, for some distance, before they open into it.

Dissection.—Open into the superior sagittal sinus by running a knife through its upper wall, from behind forwards, Figs. 31 and 32.

Sinus Sagittalis Superior (O.T. **Superior Longitudinal**).—The superior sagittal sinus begins, anteriorly, at the crista galli of the ethmoid bone, where it not infrequently communicates with the veins in the nasal cavity through the foramen cæcum. It extends backwards, grooving the cranial vault in the median plane, to the internal occipital protuberance, on the right aspect of which it becomes continuous with the right transverse sinus (O.T. lateral). Its lumen, which is triangular in cross-section, is very small anteriorly, but expands greatly posteriorly. On each side of the sinus, and opening into it, are a number of clefts between the two layers of the dura mater; they are the *lateral lacunæ*. The inferior angle of the sinus is crossed by a number of minute bands, named *chordæ Willisii*; and arachnoideal granulations bulge into it. The mouths of the superior cerebral veins open into the sinus, or into the lateral lacunæ, pouring their blood into the sinus in a direction contrary to that in which the blood flows within the channel—that is, the terminal portions of the veins are directed forwards, whilst the blood in the sinus flows backwards.

The Relation of the Arachnoideal Granulations to the Superior Sagittal Sinus and the Lateral Lacunæ.—When the granulations project themselves into the sinus or into the lateral lacunæ, they push before them a thin, continuous covering of the floor of the space, and when they project still further and encroach upon the bones of the skull they are covered also by a thin expansion of the roof of the space.

Dissection.—**In order to expose the *falx cerebri* divide the superior cerebral veins, on each side, and displace the upper parts of the hemispheres of the brain laterally.**

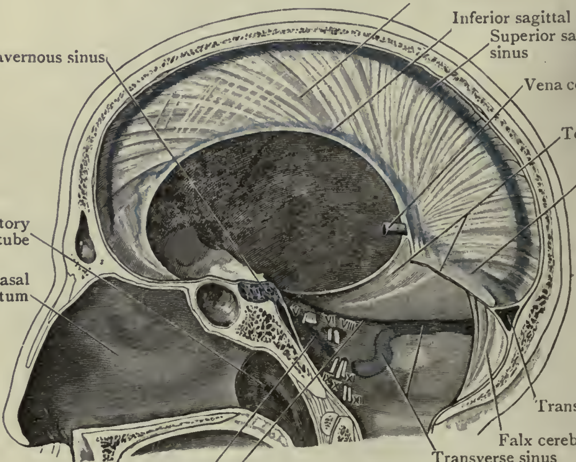


FIG. 33.—Sagittal section through the Skull, a little to the left of the median plane, to show the processes of Dura Mater.

V. Trigeminal nerve.	IX. Glossopharyngeal nerve.
VII. Facial nerve.	X. Vagus nerve.
VIII. Acoustic nerve.	XI. Accessory nerve.

XII. Hypoglossal nerve.

Falx Cerebri (Figs. 33, 34).—The falx cerebri is a sickle-shaped reduplication of the inner layer of the dura mater which descends, in the median plane, between the two cerebral hemispheres. Anteriorly, it is small, and it is attached to the crista galli of the ethmoid bone. As it passes backwards it increases in vertical extent, and the lower border of its posterior portion is attached, in the median plane, to the upper surface of the tentorium cerebelli. The anterior part of the falx is frequently cribriform, and is sometimes perforated by apertures to such an extent that it almost resembles lace-work. Between its anterior attachment to the crista galli of the ethmoid and its posterior attachment to the tentorium cerebelli its lower margin is free and concave, and it overhangs the corpus callosum, which connects the two hemispheres together, but it is not in contact with the corpus callosum except to a very slight extent posteriorly. Along each border its two layers separate to enclose a blood sinus. Along its upper convex margin runs the *superior sagittal sinus*; along its concave free border

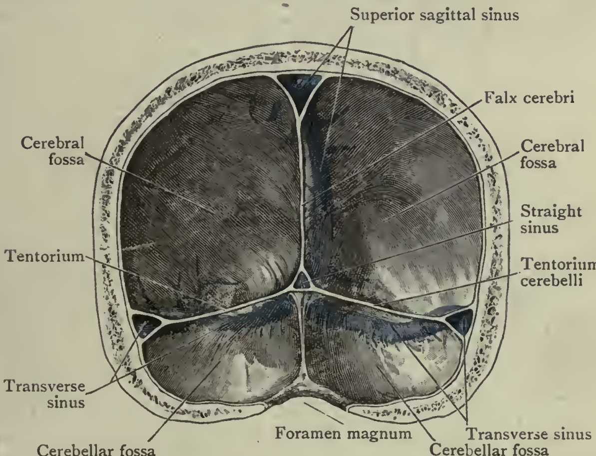


FIG. 34.—Frontal section through the Cranial Cavity in a plane which passes through the posterior part of the foramen magnum. The posterior part of the cranial cavity, from which the brain has been removed, is depicted.

courses the much smaller *inferior sagittal sinus*; whilst along its attachment to the tentorium lies the *straight sinus*.

Dissection.—Removal of the Brain.[1]—The dissectors should now proceed to remove the brain. Divide the attachment of the falx cerebri to the crista galli and pull the falx backwards. Next, remove the block upon which the head rests, support the occiput and posterior lobes of the brain with the left hand, and let the head drop well downwards. In all probability, the frontal lobes of the brain will fall away, by their own weight, from the anterior fossa of the base of the cranium, and perhaps carry with them the olfactory bulbs. Should they remain in position, however, gently raise them with the fingers, and at the same time separate the olfactory bulbs from the cribriform plate of the ethmoid with

[1] For alternative method see p. 115.

the handle of the knife. As the olfactory bulbs are raised the minute *olfactory nerves*, which perforate the cribriform plate of the ethmoid bone and pass to the bulbs, will be torn across. The large, round and white *optic nerves* (second pair of cerebral nerves) then come into view, as they pass towards the optic foramina. Divide the optic nerves and the *internal carotid arteries* will be exposed. More posteriorly, in the median plane, the infundibulum will be seen ; it is a hollow conical process which extends from the tuber cinereum, at the base of the brain, to the hypophysis (O.T. pituitary body), which lies in the fossa hypophyseos (O.T. pituitary fossa). Divide the carotid arteries and the infundibulum. Posterior to the infundibulum is the upper border of the dorsum sellæ, terminating on each side in the rounded posterior clinoid process. Passing forwards, on each side of the dorsum sellæ, is the corresponding oculomotor nerve, which must not be touched at present. A little more laterally, and on a slightly lower plane, is the free border of the tentorium cerebelli. The tentorium cerebelli is a fold of the inner layer of the dura mater which lies above the cerebellum and forms the roof of the posterior fossa of the cranium (Figs. 34, 35).

Carefully displace the temporal pole of the brain from under cover of the posterior border of the small wing of the sphenoid, which lies to the lateral side of the optic nerve and the cut end of the internal carotid artery ; then raise the temporal lobe from the floor of the middle fossa, and from the upper surface of the tentorium cerebelli, and note a thick stalk—the midbrain—ascending from the posterior fossa. Push the knife backwards, along the side of the midbrain, immediately above the level of the oculomotor nerve, and cut through the midbrain, from its lateral surface inwards to the median plane, slanting the knife so that it is in the same plane as the surface of the tentorium cerebelli. Repeat the operation in the same way on the opposite side ; then turn the hemispheres backwards, divide the great cerebral vein, immediately behind the cut midbrain, and remove the cerebrum and upper part of the midbrain from the cranium.

Place the removed cerebrum in the vault of the cranium and lay it aside. Then note the relative positions of the parts exposed. Anteriorly lies the floor of the anterior fossa of the cranium ; behind it, on a more depressed plane, the middle fossa, and still more posteriorly the sloping tentorium cerebelli.

In the median plane anteriorly is the projecting crista galli, partially dividing the anterior fossa into halves. On each side of the crista galli is the depression from which the olfactory bulb was dislodged, and still more laterally are the portions of the floor of the anterior fossa which form the roofs of the orbits ; they bulge upwards as well-marked convexities. Each lateral part of the floor of the anterior fossa terminates posteriorly in a sharp margin formed by the posterior border of the small wing of the sphenoid. That margin overhangs the anterior part of the middle fossa. It is covered with a thickening of dura mater in which runs the *spheno-parietal blood sinus*, and it terminates medially in a projecting process, the *anterior clinoid process*. On the medial side of each anterior clinoid process lie the corresponding optic nerve and internal carotid artery, and springing from the upper surface of the artery is its ophthalmic branch, which runs forward under cover of the optic nerve. Posterior to the divided ends of the internal carotid arteries, and in the median plane, is the infundibulum descending into the hypophyseal fossa, and more posteriorly, one on each side, are the projecting posterior clinoid processes. The area between the four clinoid processes is partially covered by a fold of the inner layer of the dura mater, termed the *diaphragma sellæ*. It binds

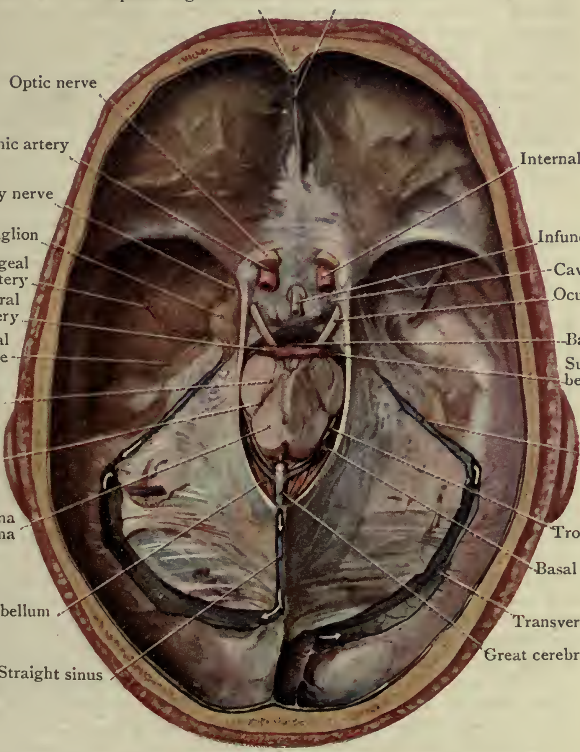


FIG. 35.—Interior of the Cranium after the removal of the cerebrum. The transverse, straight, and superior petrosal sinuses have been opened, and the dura mater has been removed from the floor of the left middle fossa.

down the hypophysis and in its centre is an aperture through which the infundibulum passes to join the hypophysis (O.T. pituitary body), which lies in the hypophyseal fossa in the base of the skull. In the anterior and posterior margins of the diaphragma sellæ are lodged respectively the *sinus intercavernosus anterior* and the *sinus intercavernosus posterior*, which should not be opened at present.

In the dura mater, on each side of the hypophyseal (pituitary) fossa, lies the corresponding cavernous sinus, which will be dissected later, and still more laterally are the depressed lateral portions of the middle cranial fossa, lined with dura mater, in which the trunk and some of the branches of the middle meningeal artery are visible. Posterior to the middle fossa lies the tentorium cerebelli covering the cerebellum. The peripheral margin of the tentorium is attached, on each side, to the posterior clinoid process, the upper margin of the petrous part of the temporal bone, the mastoid angle of the parietal bone, and to the transverse ridge on the inner surface of the occipital bone. The central or free margin crosses the attached margin, behind the posterior clinoid process, on each side, and is attached anteriorly to the apex of the anterior clinoid process. It bounds an oval opening, the door of the tent, through which pass the midbrain, surrounded by the arachnoid and the pia mater, and the posterior cerebral arteries. Traversing the midbrain, nearer its posterior than its anterior border, is a canal called the aquæductus cerebri (O.T. aqueduct of Sylvius). Posterior to the aqueduct is the lamina quadrigemina or tectum of the midbrain, and anterior to it are the right and left pedunculi (O.T. crura) cerebri. Each peduncle consists of an anterior part, *the basis pedunculi* (O.T. *crusta*), and a posterior part, *the tegmentum*, the two being separated by a lamina of dark coloured tissue, *the substantia nigra*. The bases pedunculi are entirely free from each other, but the tegmental portions are united together, anterior to the aqueduct.

Running forwards and laterally from the medial side of each peduncle to the angle between the anterior ends of the free and the attached borders of the tentorium, is the oculomotor nerve. Close to the midbrain the nerve passes between the posterior cerebral artery above and the superior cerebellar artery below; and, between the free and attached borders of the tentorium, it pierces the dura mater, in the middle fossa, and enters the wall of the cavernous sinus. Between the posterior ends of the oculomotor nerves lies the upper end of the basilar artery, dividing into the two posterior cerebral branches; and the dissectors should note that the arteries lie in an enlargement of the subarachnoid space which is known as the *cisterna interpeduncularis*. In the median plane, posterior to the midbrain, is the divided *vena cerebri magna* (O.T. *great vein of Galen*). It passes backwards and upwards, and pierces the apex of the tentorium to enter the straight sinus, which lies in the angle of union between the falx cerebri and the tentorium cerebelli.

Curving backwards around the midbrain and ending posteriorly in the great cerebral vein, on each side, is the *vena basalis*, and immediately above it, running forwards, is the slender trochlear nerve. If the free border of the tentorium is turned laterally, at the point where it is crossing the attached border, the trochlear nerve will be seen perforating the inner layer of the dura mater to enter the wall of the cavernous sinus.

When the dissectors have verified the facts noted above, they should examine the lower, free border of the falx cerebri, in which they will find the small *inferior sagittal sinus*, which terminates posteriorly, at the apex of the tentorium, in the straight sinus. The straight sinus must now be opened by carrying the knife backwards through the falx cerebri along its line of union with the tentorium. Then the falx cerebri must be cut away from the occipital bone, and as that is done the posterior part of the superior sagittal sinus will be opened up. After the falx has been removed the right and left transverse and the right and left superior petrosal sinuses must be opened by incisions carried along the attached border of the tentorium (Fig. 36). The dissectors will probably find that the superior sagittal sinus turns to the right and becomes continuous with the right transverse sinus, whilst the posterior end of the straight sinus turns to the left and joins the left transverse sinus. In a certain number of cases that arrangement is reversed, and not uncommonly, as in the specimen shown in Fig. 36, there is a communication between the right and left transverse sinuses across the front of the internal occipital protuberance. Occasionally the superior sagittal, the two transverse sinuses, the straight sinus, and the occipital sinus unite, anterior to the internal occipital protuberance, in a common dilatation, the *confluens sinuum* (O.T. torcular Herophili). The transverse sinus, on each side, runs from the internal occipital protuberance to the lateral end of the superior border of the petrous part of the temporal bone, where it dips downwards into the posterior fossa, and at the same point it is joined by the superior petrosal sinus, which runs postero-laterally, along the superior border of the petrous part of the temporal bone, from the cavernous sinus to the transverse sinus, connecting the two together.

With the point of the scalpel open the spheno-parietal sinus, which runs along the posterior border of the small wing of the sphenoid, and trace it medially to the cavernous sinus. Carefully dissect the lateral wall of the cavernous sinus and find in it :—the oculomotor nerve, dividing into two branches; the slender trochlear nerve, crossing the lateral side of the oculomotor; the ophthalmic division of the fifth and its three terminal branches —naso-ciliary, lacrimal, and frontal. Remove the remains of the lateral wall and expose the internal carotid artery and the abducens nerve (p. 234). Then remove the dura mater from the lateral part of the middle fossa on one side to expose the semilunar (O.T. Gasserian) ganglion of the trigeminal nerve; the middle meningeal artery and its two terminal branches; the accessory meningeal artery, if it is present; and the greater superficial petrosal nerve. Commence immediately to the lateral side of the anterior part of the free border of the tentorium, where a cut through the inner layer of the dura will open into a space between the two layers of the dura in which lies the *semilunar ganglion*. From the postero-medial border of the ganglion the *sensory root* passes backwards into the posterior fossa to enter the pons; and from its anterior-lateral border the *ophthalmic branch* passes upwards and forwards in the lateral wall of the cavernous sinus, the *maxillary branch* runs forwards to the foramen rotundum, and the *mandibular branch* passes downwards into the foramen ovale. By the side of the mandibular nerve the accessory meningeal artery may be found entering the cranium; and a little further posteriorly the *middle meningeal artery* will be seen passing into the middle fossa through the foramen spinosum. After entering the cranium the middle meningeal artery runs forwards and laterally, across the floor of the middle fossa, towards the lateral wall, and divides into an anterior and a posterior branch ; the former ascends on the anterior part of the lateral wall to the anterior inferior angle of the parietal bone, and the latter runs backwards and laterally, and then ascends on the inner surface of the squamous part of the temporal bone. The *greater superficial petrosal nerve* appears on the anterior surface of the petrous part of the temporal bone, through the *hiatus nervi facialis*, which lies to the medial side of an eminence called the *eminentia arcuata*. It runs forwards and medially and disappears beneath the semilunar ganglion (Fig. 36).

When the structures mentioned above have been found and cleaned, the dissectors must remove the tentorium cerebelli. Cut through the free border immediately posterior to the point where it crosses the attached border ; the trochlear nerve will be divided by the incision. Repeat the incision on the opposite side, and then cut through the membrane close to its attached border, but to the medial sides of the superior petrosal and transverse sinuses ; next divide the venæ basales at their points of junction with the vena cerebri magna ; then raise the anterior part of the tentorium and, passing the knife beneath it, separate it from the falx cerebelli, which is attached to its lower surface in the median plane. The tentorium may now be lifted out, and the arachnoid covering the upper surface of the cerebellum will be exposed.

After the upper surface of the cerebellum has been cleaned, cut through the oculomotor nerves, and then press backwards the pedunculi cerebri and the pons (Varolii), which lie immediately below them, to expose the trigeminal and the abducens nerves. Cut the trigeminal nerves as they cross the upper borders of the petrous parts of the temporal bones, and then divide the small abducens nerves, which lie more medially and at a slightly deeper level. Press the pons and cerebellum still further back and divide the facial and acoustic nerves as they enter the internal acoustic meatus. Below the acoustic nerves lie the glossopharyngeal, vagus, and accessory nerves. They also must be cut ; and the roots of the hypoglossal nerves, which lie deeper and more medially, must be identified and divided. The pons can then be displaced still further backwards and the front of the medulla oblongata will be brought into view. Pass the knife downwards, anterior to the medulla oblongata, into the vertebral canal, and, cutting firmly backwards and laterally, on each side, divide the medulla spinalis and the vertebral arteries. Withdraw the knife, pass two fingers downwards, anterior to the medulla oblongata, and lift it and the pons and the cerebellum out of the posterior fossa. Place the lower parts of the brain, which collectively constitute the hind brain, with the hemispheres previously removed, and then examine the cut ends of the cerebral nerves and the blood sinuses which lie in the region of the posterior fossa (Fig. 36).

In the upper end of the vertebral canal lies the upper extremity of the severed medulla spinalis, attached, on each side, to the margin of the foramen magnum by the uppermost dentation of the ligamentum denticulatum. Anterior to the ligamentum denticulatum, on each side, is the vertebral artery, and still more anteriorly, on a slightly deeper plane, the fila of the anterior root of the first cervical nerve may be distinguished. At a higher level, on each side, the two rootlets of the hypoglossal nerve pierce the dura, as they pass into the hypoglossal canal (O.T. anterior condyloid foramen). The spinal root of the

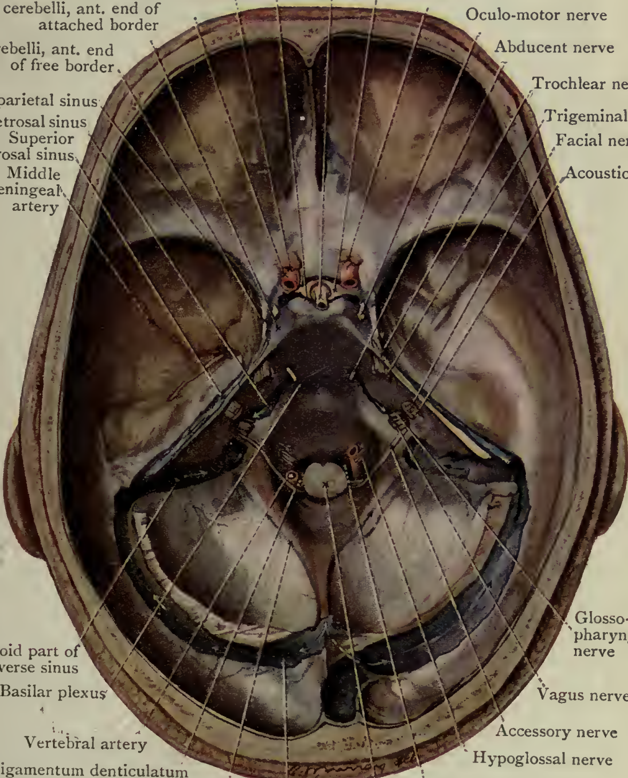


FIG. 36.—Dissection of the Interior of the Cranium after the removal of the brain and the tentorium cerebelli.

accessory nerve passes through the foramen magnum into the cranium, posterior to the ligamentum denticulatum, and, turning laterally over the margin of the foramen magnum, it joins the cerebral fibres of the accessory and the vagus nerves, with which it passes through an aperture in the dura opposite the jugular foramen. Immediately above the accessory and vagus nerves the smaller trunk of the glossopharyngeal nerve pierces the dura. Above the glossopharyngeal nerve the acoustic nerve and the motor and sensory roots of the facial nerve pass into the internal acoustic meatus, accompanied by the small auditory branch of the basilar artery and the auditory vein. The two roots of the facial nerve lie in a groove on the upper and anterior aspect of the acoustic nerve, the small sensory root (O.T. pars intermedia) being situated between the motor root and the acoustic nerve. The small motor and the large sensory root of the trigeminal nerve pass through an opening in the dura which lies above and medial to the internal acoustic meatus ;

FIG. 37.—Section through the Head a little to the right of the median plane. It shows the posterior cranial fossa and the upper part of the vertebral canal after the removal of the brain and the medulla spinalis.

and the abducens nerve pierces the dura mater below and to the medial side of the opening for the trigeminal nerve, opposite the side of the base of the dorsum sellæ. The small trochlear nerve pierces the inferior surface of the free border of the tentorium at the point where it is crossing the attached border.

After the dissectors have familiarised themselves with the positions of the cerebral nerves as they pierce the dura mater, they should examine the falx cerebelli and complete the display of the cranial blood sinuses.

Falx Cerebelli.—The falx cerebelli is a small sagittal fold of the inner layer of the dura mater which projects forwards, between the lateral lobes of the cerebellum, from the internal occipital crest (Figs. 33, 34).

Sinus Transversus (O.T. **Lateral**).—The horizontal part of the transverse sinus has already been traced from the internal occipital protuberance to the superior border of the petrous part of the temporal bone, where it turns downwards to the jugular foramen. At first the descending portion runs downwards, on the inner surface of the mastoid part of the temporal bone, and then forwards and again downwards across the upper and anterior surfaces of the jugular process of the occipital bone. On account of the sinuosity of its course this part is called the *sigmoid portion of the transverse sinus* (Fig. 36).

Dissection.—**Open the sigmoid part of the sinus and find the mouth of the mastoid emissary vein in its posterior border, about half-way down.**

The dissectors should now obtain the basal part of a macerated skull and should note the relation of the transverse sinus to the outer surface. They will find that the position of the sinus can be indicated on the external surface, by a line which commences at the external occipital protuberance, passes forwards, with a slight upward convexity, along the superior nuchal line to the upper part of the mastoid part of the temporal bone and then descends to the level of the lower margin of the external meatus (Figs. 38, 204).

Sinus Occipitalis.—The occipital sinus is not uncommonly absent. When it is present it commences in the right or left transverse sinus or the confluens sinuum, and descends for a short distance in the posterior border of the falx cerebelli. It terminates below in two branches, which leave the falx cerebelli and run along the borders of the foramen magnum, between the layers of the dura mater, to terminate anteriorly in the lower ends of the transverse sinuses.

Sinus Petrosus Inferior.—The inferior petrosal sinus lies along the posterior border of the petrous part of the temporal bone, extending from a point lateral to the opening for the abducens nerve to the medial side of the opening in the dura for the glossopharyngeal nerve of the same side. Lay the sinus open. It opens anteriorly into the cavernous sinus, from which it receives blood, and posteriorly it passes through the jugular foramen to join the upper end of the internal jugular vein.

Plexus Basilaris.—The two inferior petrosal sinuses are connected together, across the upper surface of the basilar part of the occipital bone, by a plexus of small venous channels, to which the term basilar plexus is applied. Unless the channels happen to be distended with blood the dissectors will probably be unable to display the plexus (Fig. 36).

The dissectors should note that the dura mater is much more firmly attached to the bones of the base than it was to the bones of the vertex, a fact which should have attracted their attention as they removed the membrane from the floor of the middle fossa. They should note also that it gives sheaths to the nerves which pierce it, and that at the margins of the various foramina its outer layer becomes continuous with the periosteum on the outer surface of the cranium, whilst at the margin of the foramen magnum the inner layer becomes continuous with the single layer of dura mater which surrounds the medulla spinalis; and that, at the same level, the arachnoid and pia mater of the brain become continuous with the arachnoid and pia mater of the spinal medulla (O.T. spinal cord). Before terminating the survey of the interior of the cranium, the dissectors should revise their knowledge of the blood vessels, and their relations to the dura mater; and they should remove the hypophysis (O.T. pituitary body) and investigate its naked-eye structure.

Sinus Duræ Matris.—*Four blood sinuses lie in the median plane*: (1) the superior sagittal sinus, in the upper or attached border of the falx cerebri; (2) the inferior sagittal sinus, in the free part of the lower border of the falx cerebri; (3) the straight sinus, along the line of attachment of the falx cerebri with the tentorium cerebelli; (4) the occipital sinus, in the upper part of the attached border of the falx cerebelli.

Two sinuses lie in a higher horizontal plane: they are the spheno-parietal sinuses, which run along the posterior borders of the small wings of the sphenoid bone.

Six sinuses lie in a lower horizontal plane: (1) the two cavernous sinuses, at the sides of the body of the sphenoid; (2) the two superior petrosal sinuses, along the upper borders of the petrous parts of the temporal bones, in the anterior parts of the attached border of the tentorium cerebelli; (3) the horizontal parts of the transverse sinuses, in the posterior parts of the attached border of the tentorium. The terminal parts of the transverse sinuses descend along the anterior parts of the lateral walls of the posterior fossa.

Two sinuses run obliquely downwards, backwards, and laterally: they are the two inferior petrosal sinuses.

Three sinuses run transversely, connecting paired sinuses of opposite sides: (1) the anterior intercavernous sinus, in the anterior border of the diaphragma sellæ; (2) the posterior intercavernous sinus, in the posterior border of the diaphragma sellæ; and (3) the basilar plexus, which connects together the inferior petrosal sinuses, across the upper surface of the basilar part of the occipital bone.

Alternative Method of removing the Brain.—If it is thought desirable to remove the brain entire, by the more rapid but less instructive method usually adopted in the post-mortem room, then the following steps should be taken after the falx cerebri has been detached from the crista galli and the dura mater lining the vault of the cranium has been thrown aside (see p. 105).

Remove the block upon which the head has been resting, supporting the occiput and the posterior part of the brain with the left hand, and let the head drop well downwards, and, in all probability, the weight of the frontal lobes will draw them away from the floor of the anterior fossa of the skull, and possibly the *olfactory bulbs* may be carried with them. If the olfactory bulbs remain in position on the cribriform plates of the ethmoid at the sides of the crista galli, gently raise them with the handle of the scalpel and press them backwards on to the lower surfaces of the frontal lobes. As the olfactory bulbs are raised the *olfactory nerve filaments*, which enter their lower surfaces after passing through the cribriform plates, are torn. As the frontal lobes are pressed backwards, the large, round and white *optic nerves* come into view, as they are approaching the optic foramina. When they are divided the *internal carotid arteries* will be exposed. More posteriorly, in the median plane, lies the *infundibulum*, a hollow conical process which connects the *hypophysis cerebri* (O.T. *pituitary body*) with the *tuber cinereum* at the base of the brain; and more laterally are the *oculomotor nerves*. Sever each of the structures mentioned in turn. On the lateral side of each oculo-motor nerve lies the medial or free border of the tentorium cerebelli, passing forwards to be attached to the anterior clinoid process. Turn that margin aside with the point of the knife, and the small *trochlear nerve* (fourth cerebral nerve) will be brought into view. It lies under shelter of the free border of the tentorium, and should be divided at this stage. The head must in the next place be turned forcibly round, so that the face is directed over the left shoulder. Raise the posterior part of the right cerebral hemisphere with the fingers, and note that it rests upon the tentorium cerebelli—a broad sloping process of dura mater which intervenes between it and the cerebellum. Divide the tentorium along its attached border, and take care whilst doing that not to injure the subjacent cerebellum. Next turn the head so as to bring its left side uppermost, and treat the tentorium on that side in the same manner. Now let the brain fall well backwards ; then the pons and medulla will be drawn away from the anterior wall of the posterior fossa of the skull, and the nerves in the posterior fossa will come into view. They are the two parts of the *trigeminal nerve* (fifth cerebral nerve), perforating the dura mater near the apex of the petrous portion of the temporal bone ; the *abducent nerve* (sixth cerebral nerve), piercing the dura mater behind the dorsum sellæ of the sphenoid bone ; the *facial nerve* and the *acoustic nerve*, disappearing into the internal acoustic meatus ; the *glossopharyngeal*, the *vagus*, and the *accessory nerves*, leaving the skull through the jugular foramen ; and the two slips of the *hypoglossal nerve*, piercing the dura mater over the hypoglossal canal (O.T. anterior condyloid foramen). Each in turn will be displayed upon each side. They must be divided in the order mentioned, except that, in the case of the nerves passing out of the cranium through the jugular foramina, the dissector should endeavour to leave the accessory of the right side intact within the cranium, by dividing its roots of origin from the medulla oblongata, whilst on the other side he should remove it with the brain. The accessory nerve is readily recognised because its spinal part ascends from the vertebral canal into the cranial cavity through the foramen magnum. Now, thrust the knife into the vertebral canal, and divide the medulla spinalis and the vertebral arteries, as they turn forwards upon the upper part of the medulla spinalis (O.T. spinal cord) ; then sever the accessory nerve of the left side, and the roots of the first pair of spinal nerves. When that has been done let the head fall well downwards, gently dislodge the medulla oblongata and cerebellum, and the whole brain can be removed. The vena cerebri magna (Galen), as it passes from the interior of the brain to enter the straight sinus, is ruptured as the brain is removed. The dissector should now return to p. 112, and should study the positions and relations of the cranial blood sinuses.

Meningeal Veins.—In addition to the named blood sinuses, venous channels accompany the meningeal arteries, and more particularly the trunks and branches of the middle meningeal artery. The meningeal veins are of wider calibre than the corresponding arteries, and lie external to them, in the grooves on the inner surfaces of the cranial bones. When the arteries are distended they compress the middle parts of the veins and drive the blood into their anterior and posterior margins. When that occurs each artery appears to be accompanied by two veins, a circumstance which is probably responsible for the statement that some of the meningeal arteries have venæ comites.

Emissaria.—Emissary veins are blood channels which connect the sinuses of the dura mater with the veins which lie outside the cranium. They are: (1) Emissary veins connected with the superior sagittal sinus—(*a*) from the anterior extremity of the sinus an emissary vein passes through the foramen cæcum; this vein divides below, and either

PLATE II

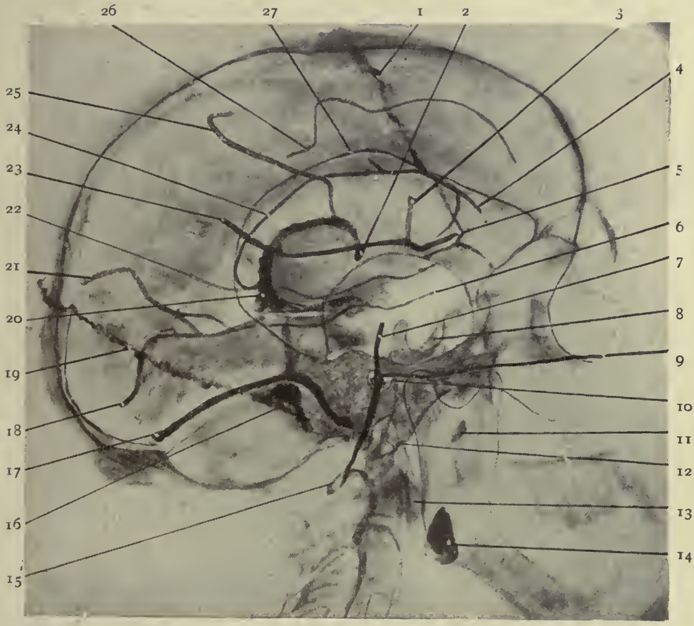


FIG. 38.—Radiograph of Half a Head in which the various fissures, etc., shown have been made visible by metal filaments, by cords impregnated with metallic powders, or by means of metallic powder.

1. Coronal suture.
2. Interventricular foramen.
3. Ascending limb of lateral fissure.
4. Inferior frontal sulcus.
5. Anterior horizontal limb of lateral fissure.
6. Second temporal sulcus.
7. Basilar artery.
8. Internal carotid artery at side hypophyseal fossa.
9. Line of superior border of external acoustic meatus and lower margin of orbit.
10. External acoustic meatus.
11. Pharyngeal orifice of auditory tube.
12. Body of occipital bone.
13. Anterior arch of atlas.
14. Position of tonsil.
15. Vertebral artery.
16. Fourth ventricle.
17. Transverse sinus.
18. Calcarine fissure.
19. Lambdoid suture.
20. Chorioid plexus.
21. Parieto-occipital fissure.
22. First temporal sulcus.
23. Posterior limb of lateral fissure.
24. Upper surface of corpus callosum.
25. Central sulcus.
26. First frontal sulcus.
27. Temporal ridge.

PLATE III

FIG. 39.—Radiograph of Skull of a Child—lateral view—showing the relation of the internal carotid artery to the base of the skull. The portion of the artery shown was injected. (Dr. H. M. Traquair.)

becomes continuous with the veins of the nasal fossæ, or its branches pass through foramina in the nasal bones and join the angular veins; (*b*) two parietal emissary veins, which pass through the parietal foramina and connect the superior sagittal sinus with the occipital veins. (2) Emissary veins connected with the transverse sinuses—(*a*) two mastoid emissary veins, one on each side, pass through the mastoid foramina and connect the sigmoid parts of the transverse sinuses with the posterior auricular veins; (*b*) two posterior condyloid veins, one on each side, pass through the condyloid canals and connect the lower ends of the transverse sinuses with the plexuses of veins in the sub-occipital triangles. One or both of the posterior condyloid veins may be absent. (3) Emissary veins connected with the cavernous sinuses—(*a*) a vein which traverses the foramen ovale, or the foramen Vesalii, and connects the cavernous sinus with the plexus of veins around the external pterygoid muscle; (*b*) a plexus of veins which passes through the temporal bone with the internal carotid artery, and connects the cavernous sinus with the pharyngeal venous plexus; (*c*) in a sense, the ophthalmic vein may be considered an emissary vein, for, although under ordinary circumstances it is a tributary of the sinus, blood can flow through it, in the opposite direction, from the sinus into the orbit, and then along the tributaries which connect the ophthalmic vein with the angular vein, and along the channels which connect the ophthalmic vein, through the inferior orbital fissure, with the veins in the infratemporal region.

The Arteries of the Cranial Cavity.—(1) *The vertebral arteries*; (2) *the internal carotid arteries*; (3) *the meningeal arteries.*

Arteriæ Vertebrales.—The vertebral arteries, right and left, pierce the spinal dura mater below the foramen magnum, through which they enter the cranium. As each artery passes through the foramen it lies anterior to the highest dentation of the ligamentum denticulatum, and it passes between the hypoglossal and first cervical nerves. It was divided when the hind brain was removed, and its cut extremity lies near its point of entrance into the cranial cavity (Figs. 36, 37).

Arteriæ Carotides Internæ.—Each internal carotid artery enters the cranium at the foramen lacerum, between the apex of the petrous part of the temporal bone and the body of the sphenoid, where it pierces the outer layer of the dura mater.

Then it runs forwards, in the cavernous sinus, to the medial side of the anterior clinoid process, where it turns upwards, pierces the inner layer of the dura mater and the arachnoid, and gives off its ophthalmic branch, which runs forwards below the optic nerve into the orbit. The artery was cut immediately behind its ophthalmic branch during the early stages of the removal of the brain (Figs. 36, 39).

Meningeal Arteries.—The meningeal arteries are the nutrient arteries of the dura mater, and of the inner table and diploe of the cranial bones. They are derived from a great number of different sources, but the only one of any size is the *middle meningeal branch* of the internal maxillary artery. The others are small twigs, and, except in a well-injected subject, will not be easily made out. They are: (1) *anterior meningeal*, from the anterior ethmoidal artery; (2) a meningeal branch of the lacrimal artery; (3) the *accessory meningeal*, from the internal maxillary artery; (4) some small branches from the ascending pharyngeal, occipital, and vertebral arteries.

Each *middle meningeal artery* is a branch of the corresponding internal maxillary artery. It enters the cranium through the foramen spinosum of the sphenoid bone, and divides, upon the inner surface of the great wing of that bone, into two large terminal branches. The anterior of the two branches ascends upon the great wing of the sphenoid, and upon the anterior inferior angle of the parietal bone, grooving both deeply, whilst the posterior branch turns backwards and upwards upon the squamous portion of the temporal bone. The branches which proceed from the two main divisions spread out widely and, with the accompanying venous channels, occupy the arborescent grooves on the inner surface of the cranial vault (Fig. 204).

The vein which accompanies the middle meningeal artery passes through the foramen spinosum and ends in the plexus around the external pterygoid muscle.

Each *anterior meningeal artery* proceeds from the anterior ethmoidal artery as it accompanies the anterior ethmoidal nerve across the cribriform plate of the ethmoid bone. It supplies a limited area of dura mater and bone in the anterior fossa of the cranium.

The *meningeal branch of the lacrimal artery* enters the middle cranial fossa through the superior orbital fissure, and it anastomoses with the rami of the anterior division of the middle meningeal artery.

The *accessory meningeal artery* (O.T. *small meningeal*) is somewhat inconstant; it arises either directly from the internal maxillary or from the middle meningeal, and enters the cranium through the corresponding foramen ovale, but it should not be looked for at the present stage, as it is best examined along with the semilunar (O.T. Gasserian) ganglion and the three divisions of the trigeminal nerve.

The *meningeal branches from the ascending pharyngeal arteries* are the terminal twigs of those vessels. They enter the cranium through the lacerate and jugular foramina, and

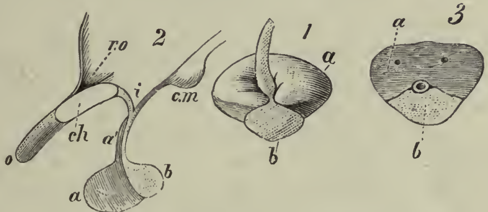


FIG. 40.—1, Hypophysis; 2, in median section; 3, in horizontal section. (Schwalbe.)

a. Anterior lobe.
b. Posterior lobe.
cm. Corpus mamillare.
i. Tuber cinereum.
ch. Optic chiasma in section.
ro. Optic recess of the third ventricle.
o. Optic nerve.
a'. Infundibulum, with projection from anterior lobe upwards anterior to it.

through the hypoglossal canal (O.T. anterior condyloid foramen). The branch which passes through the jugular foramen is the largest.

The *meningeal branches of the occipital and vertebral arteries* are small, and are distributed in the posterior cranial fossa. The former enter through the jugular, mastoid, and parietal foramina, the latter through the foramen magnum.

The *meningeal veins* may be regarded as being arranged in two sets: one set consists of small channels which pour their blood into the blood sinuses; the other set is composed of veins which accompany the meningeal arteries and carry their blood to venous trunks on the exterior of the cranium.

Dissection.—Cut away the overhanging margins of the diaphragma sellæ and carefully dislodge the hypophysis from the fossa hypophyseos (pituitary fossa) of the sphenoid bone; then, with a chisel chip away the floor of the hypophyseal fossa and open up the sphenoidal air sinuses—right and left—which lie in the body of the sphenoid bone below the fossa. They are generally of unequal size and may be replaced in some cases by a single cavity. Attempt to pass a probe through the aperture in the anterior wall of each sinus into the corresponding section of the nasal cavity (Fig. 110).

Hypophysis Cerebri (O.T. **Pituitary Body**) (Fig. 40).—The hypophysis is an oval structure, slightly flattened from above downwards, and with its long axis placed transversely. It consists of a large anterior lobe, and a smaller posterior lobe. The anterior lobe is hollowed out posteriorly so as to form a concavity for the lodgment of the posterior lobe. If a sagittal section is made through the hypophysis, the line of separation between the two lobes is seen very distinctly. The infundibulum, which connects the hypophysis with the tuber cinereum of the brain, is attached to the posterior lobe only (Fig. 40, 1). Thus, even in the adult, there is a clue to the different modes of development of the two lobes. The posterior lobe is derived from the brain, whilst the anterior lobe is an off-shoot from the primitive buccal cavity.

When the inspection of the interior of the cranium is completed the dissectors must fill the cranial cavity with tow steeped in preservative solution; replace the skull-cap in position and retain it by bringing the scalp flaps over it, and stitching them accurately together. The brain must be put in a jar in a 5 per cent solution of formalin and placed aside till the dissection of the remaining parts of the head and neck is finished.

THE ANTERIOR PART OF THE NECK.

After the skull-cap has been replaced and the scalp has been stitched over it, let the head hang down over the end of the table, pull the chin as far from the sternum as possible and fix it in position with hooks. Then examine the region of the front of the neck. It is a large triangular area, bounded laterally by the anterior borders of the sterno-mastoid muscles, above by the lower border of the mandible, and below by the middle part of the upper border of the manubrium sterni; and it is divided by the median plane into two smaller subsidiary triangles, *the anterior triangles of the neck*, each of which is bounded above by the mandible, behind by the sterno-mastoid, and in front by the middle line of the neck. Pass the index finger from the chin to the sternum along the median line and locate in sequence the body of the hyoid bone, the angular anterior border of the thyreoid cartilage, the rounded arch of the cricoid cartilage and the rings of the trachea. The latter are partly masked by the isthmus of the thyreoid gland. Place the thumb and the forefinger on the body of the hyoid bone and carry them backwards, one on each side, along its greater cornua. Note that the posterior ends of the cornua lie immediately in front of the anterior borders of the sterno-mastoid muscles. Above the body of the hyoid bone lies the *submental triangle* bounded superiorly by the mylo-hyoid muscles, which form the diaphragm of the mouth; and above each greater cornu is the corresponding *submaxillary region.* Between the body of the hyoid bone and the upper margin of the thyreoid cartilage is the thyreo-hyoid space, bounded posteriorly by the middle part of the thyreo-hyoid membrane, which lies anterior to the upper part of the pharynx and the middle of the epiglottis (Fig. 110). Trace the upper border of the thyreoid cartilage backwards and note that it terminates, on each side, in a pointed projection, the superior cornu, which lies immediately in front of the anterior border of the sterno-mastoid. Between the lower margin of the thyreoid cartilage and the upper border of the cricoid cartilage lies the cricothyreoid ligament, forming part of the anterior wall of the lower portion of the larynx.

The dissectors should make themselves thoroughly familiar with the landmarks mentioned above, both on their own necks and on the necks of their friends, and they should note that, whilst in the dead subject there may be some difficulty in palpating the isthmus of the thyreoid gland, as it crosses anterior to the second, third and fourth rings of the trachea, they will have no difficulty in locating the small soft cushion-like mass in the living subject.

Dissection.—The skin was cut along the lower border of the mandible at the commencement of the dissection of the face; now, make a median incision through it, from the chin to the sternum, and turn the triangular flap, thus marked out, backwards and laterally, to a short distance beyond the anterior margin of the sterno-mastoid. When that is done the superficial fascia covering the anterior triangle on each side will be exposed; it is thickest and most laden with fat in the submental region. In the upper and posterior part of it lie the fibres of the platysma, running upwards and forwards towards the mandible. Some of the anterior fibres of the muscle gain attachment to the anterior part of the lower border of the mandible, and some decussate with their fellows of the opposite side beneath the chin. The posterior fibres ascend into the face, where they have already been followed to their connection with the risorius and the orbicularis oris (p. 7). Cut through the platysma along the anterior border of the sterno-mastoid and turn it upwards, dividing the twigs of the cervical branch of the facial nerve which supply it. Secure the two terminal branches of the *nervus cutaneus colli* (O.T. transverse cervical nerve), crossing the middle of the sterno-mastoid ; trace its two branches forwards, and note the union between the upper branch and the cervical branch of the facial nerve, which was found passing downwards and forwards behind the angle of the mandible in a previous dissection (see p. 15). In the superficial fascia of the submental region and the anterior part of the submaxillary region secure the tributaries of the anterior jugular vein ; trace them downwards to the trunk of the vein, and follow the trunk to the point where it pierces the deep fascia ; then remove the superficial fascia and expose the deep fascia of the anterior region. Note that the deep fascia extends in a continuous layer from the mandible to the sternum and from the sterno-mastoid of one side to that of the other side. Note, further, that it is attached to the body and the greater cornua of the hyoid bone. The latter attachment separates the infra-hyoid muscles, which lie in the lower part of the neck, from the supra-hyoid muscles, which are situated in the region of the floor of the mouth.

The dissectors will remember that in the course of the dissection of the posterior triangle they met with several layers of the deep fascia. A similar division into layers exists in the anterior region, and the opportunity should be taken, whilst the fascia is still uninjured, to demonstrate certain of the layers and the presence of the spaces between them.

The Suprasternal Space.—Make a transverse incision through the deep fascia, immediately above the sternum, and two vertical incisions, one along the anterior border of each sterno-mastoid muscle. Carry the latter incisions upwards for about 38 mm. (one and a half inches), and turn the flap of fascia marked out upwards. The space opened into by the reflection of the first layer of deep fascia of the lower part of the neck is the *suprasternal space* (Burns). Remove the areolar tissue which fills it, find the lower parts of the anterior jugular veins and the transverse anastomosis between them, and expose the second layer of deep fascia, which forms the posterior boundary of the space and covers and binds together the infra-hyoid muscles of opposite sides. Pass the handle of the scalpel downwards along the posterior wall of the space, and note that it terminates, a short distance below the upper border of the sternum, where the second layer of fascia is attached to the posterior surface of the manubrium, immediately above the origins of the infra-hyoid muscles. If the handle of the knife is passed laterally, along the posterior wall of the space, it will pass deep to the sterno-mastoid into the posterior triangle (see p. 34), and if it is pushed upwards it will be stopped by the union of the first and second layers of the deep fascia, about half-way between the sternum and the thyreoid cartilage. The attachments of the second layer of deep fascia of the lower part of the neck may be summarised as follows. It is attached, below, to the posterior surface of the manubrium sterni and to the posterior border of the clavicle, to which it binds the posterior belly of the omo-hyoid (p. 34). Above, it fuses with the more superficial layer, along an oblique line which ascends from the level of the coracoid process to the level of the upper end of the trachea. Above that level it forms, with the superficial layer, a common lamella, which ascends on the infra-hyoid muscles to gain attachment to the body and greater cornu of the hyoid bone. The space between the two layers contains, in the region of the anterior triangle, the lower parts of the anterior jugular veins, the anastomosis between them, and the areolar tissue in which they are embedded. In the posterior triangle its contents are the lower end of the external jugular vein, the terminations of the transverse cervical and transverse scapular veins, the transverse scapular artery, and areolar tissue. Note that the *anterior jugular vein*, on each side, arises in the superficial fascia of the submental region and descends superficial to the deep fascia in the upper part of the neck ; then it pierces the first layer of deep fascia and lies between the two layers, where it anastomoses with its fellow of the opposite side ; finally, it turns laterally, deep to the sterno-mastoid, and terminates in the external jugular vein at the anterior boundary of the subclavian part of the posterior triangle.

Make two incisions through the deep fascia of the upper part of the anterior triangle, one along the lower border of the mandible, from the angle to a point 12.5 mm. (half an inch) from the chin, and a second at right angles to the first, from its middle to the greater cornu of the hyoid bone. Whilst making the horizontal incision avoid injuring the *external maxillary artery* (O.T. facial) and the *anterior facial vein*, which pierce the deep fascia at the level of the anterior border of the masseter. Reflect the two triangular flaps of fascia marked out by the incisions, and expose the lower surface of the *submaxillary salivary gland*, the *submaxillary lymph glands*, the *anterior* and *posterior bellies of the digastric muscle*, the lower part of the *stylo-hyoid muscle*, and a further part of the anterior facial vein.

The majority of the submaxillary lymph glands lie along the lower border of the mandible, on the superficial surface of the submaxillary gland. The anterior facial vein crosses the posterior part of the submaxillary gland superficially. The external maxillary artery dips deeply between the lower border of the mandible and the submaxillary gland. The posterior and lower part of the submaxillary gland usually overlaps the stylo-hyoid and the posterior belly of the digastric muscles, and not infrequently it overlaps the greater cornu of the hyoid bone also. Its anterior border may overlap the anterior belly of the digastric. Raise the lower border of the gland and expose another layer of deep fascia covering the muscles which lie deep to the gland. Place the handle of the knife on that fascia and push it gently upwards. Note that it passes upwards to the level of the mylo-hyoid line on the medial surface of the mandible, to which the mylo-hyoid muscle is attached. The fascial sheath in which the submaxillary gland is enclosed consists, therefore, of a superficial layer of deep fascia which extends from the greater cornu of the hyoid bone to the lower border of the mandible, and a deeper layer which passes from the greater cornu of the hyoid to the mylo-hyoid line of the mandible. In front of the anterior belly of the digastric, the two layers blend with the single layer of deep fascia which covers the lower surfaces of the mylo-hyoid muscles. Behind the posterior belly of the digastric they unite with the connective tissue in which the carotid vessels are embedded.

When the details of the deep fascia have been examined, the sterno-mastoid should be studied.

M. Sternocleidomastoideus.—The sterno-mastoid muscle lies between the anterior and posterior triangles of the neck (Fig. 43). It is attached, below, by two heads—a sternal and a clavicular. The sternal head is rounded, and chiefly tendinous; it springs from the upper part of the anterior surface of the manubrium sterni. The clavicular head is broad and fleshy, with only a few tendinous fibres intermixed; it arises from the medial third of the upper surface of the clavicle. A narrow interval filled with fascia separates the heads below, but at a higher level the sternal portion overlaps the clavicular, and half-way up the neck the two heads unite into a fleshy mass which ascends to the mastoid portion of the temporal bone and occiput. There the muscle expands somewhat. At its insertion it is thick and tendinous where it is attached to the fore-part and lateral surface of the mastoid process; posteriorly it is thin and aponeurotic, and is inserted into rather more than half of the corresponding superior nuchal line of the occipital bone. In the dissection of the back, the latter part of the muscle was detached from the occiput.

The dissectors should note that the insertion of the sterno-mastoid into the skull is mainly posterior to the transverse axis of rotation of the atlanto-occipital joint. Therefore if one sterno-mastoid acts the head is drawn downwards to that side and the face is turned to the opposite side and tilted upwards. If both sterno-mastoids act simultaneously the head is drawn backwards. The muscle is supplied by the spinal part of the accessory nerve and by the second cervical nerve.

Dissection.—Turn the anterior border of the sterno-mastoid backwards and search for the arteries which supply it. At the level of the angle of the mandible the *sterno-mastoid branch of the occipital artery* will be found entering the deep surface of the muscle.

At the level of the cricoid cartilage the *sterno-mastoid branch of the superior thyreoid artery* enters the muscle, and a short of the thyreoid body, secure the tributaries of the *inferior thyreoid veins* at its lower border, and follow them downwards to the upper aperture of the thorax; then clearing away the remains of the pretracheal fascia they should display the front of the lower part of the cervical portion of the trachea upon which the inferior thyreoid veins descend. At this stage a small artery, the *thyreoidea ima*, may occasionally be found ascending on the front of the trachea to the isthmus of the thyreoid body.

When the dissection of the lower part of the infra-hyoid area is completed return to the upper part. Clean the anterior ends of the crico-thyreoid muscles which spring from the cricoid cartilage; they run upwards and laterally, one on each side. Between the crico-thyreoid muscles, on a deeper plane, secure the *crico-thyreoid arteries*, which anastomose across the front of the median *crico-thyreoid ligament*. Note that the median crico-thyreoid ligament is attached below to the upper border of the cricoid cartilage, and above to the lower border of the thyreoid cartilage; then push the handle of the scalpel or a broad probe backwards along the surface of the *conus elasticus*, which is continuous with the median ligament, and note that it ascends medial to the thyreoid cartilage. It becomes continuous above (see Fig. 126), with the *vocal ligament*, but that fact cannot be demonstrated at the present stage of the dissection. Next clean the prominent anterior part of the thyreoid cartilage, which forms the laryngeal prominence in the front of the neck. Lastly, clean away the fascial tissue between the upper part of the thyreoid cartilage and the body of the hyoid bone and display the *middle thyreo-hyoid ligament* which extends from the upper border of the thyreoid cartilage behind the body of the hyoid bone to its upper border. As the fascia is removed from the upper part of the median thyreo-hyoid ligament behind the body of the hyoid bone a small bursal sac will be opened. It facilitates the movement of the hyoid bone over the upper part of the thyreoid cartilage during deglutition. When the dissection is completed revise the structures which have been exposed.

The Middle Line of the Neck.—In the *supra-hyoid part* of the median portion of the neck lie the structures which are concerned in the construction of the floor of the mouth. The dissector will have noticed already that the fatty superficial fascia was more fully developed there than elsewhere in the neck, and that the anterior margins of the two platysma muscles met and decussated in the median plane, for 10 or 12 mm. (about half an inch), below the chin. The anterior attachments of the bellies of the two digastric muscles to the mandible, one on each side of the symphysis, was noted. Thence they descend towards the hyoid bone, and diverge slightly from each other so as to leave between them a narrow triangular space, called the *submental triangle* (Fig. 44). The floor of the space is formed by the anterior portions of the two mylo-hyoid muscles, whilst bisecting the floor of the triangle, in the median plane, is the fibrous raphe into which those muscles are inserted. Not infrequently the medial margins of the digastric muscles send decussating fibres across the interval. Within the submental triangle are the *submental*

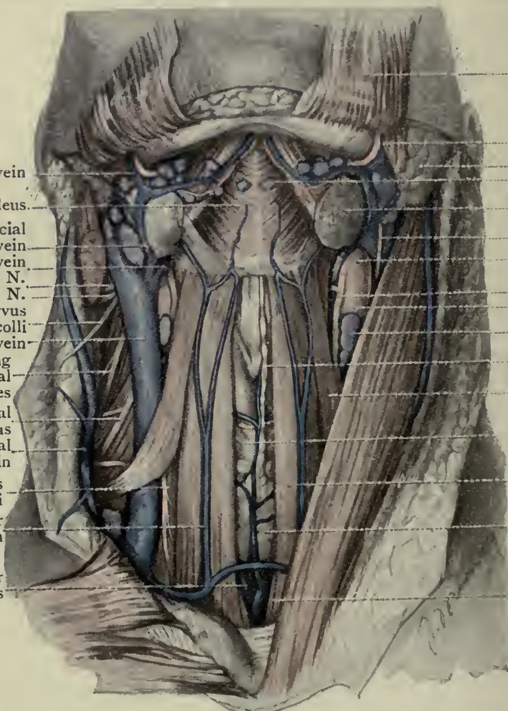


FIG. 44.—Dissection of the Front of the Neck. The Right Sterno-mastoid has been removed.

glands, which receive lymph from the median part of the lower lip and chin and the anterior part of the tongue.

In the median area of the *infra-hyoid part* there is a narrow intermuscular interval, bounded on each side, above, by the medial margins of the sterno-hyoid muscles, and to a smaller extent, below, by the medial margins of the sterno-thyreoid muscles (Fig. 44); more laterally lie the anterior bellies of the omo-hyoid muscles. In the median intermuscular interval the following structures will be found: (1) the median part of the thyreo-hyoid membrane; (2) the anterior border of the thyreoid cartilage, with the projecting prominentia laryngea (O.T. pomum Adami) at its upper end; (3) the arch of the cricoid cartilage; (4) the crico-thyreoid ligament, with the anastomosis between the crico-thyreoid arteries, and the anterior ends of the crico-thyreoid muscles; (5) the first ring of the trachea, with the anastomosis between the medial terminal branches of the superior thyreoid arteries; (6) the isthmus of the thyreoid gland; (7) the inferior thyreoid veins, and (8) the lower cervical rings of the trachea. Occasionally the third or middle lobe of the thyreoid gland and the levator glandulæ thyreoideæ, or one or other of them, is found extending upwards from the isthmus of the thyreoid gland. When it is present the middle lobe either terminates above in a pointed extremity or becomes continuous with a fibrous cord, the remains of the thyreo-glossal duct, which disappears in the region of the hyoid bone. The levator extends from the isthmus or from the third lobe, and is attached, above, to the lower border of the hyoid bone.

Dissection.—The superficial layers of the deep fascia must now be removed from the whole area of each anterior triangle, and for that purpose, and for the satisfactory dissection of the contents of the triangles, it is necessary that the head be turned well over to the opposite side; therefore the dissectors must arrange to work alternately.

Commence with the digastric triangle. Its boundaries are the lower border of the mandible and the two bellies of the digastric muscle.

Its contents are: (1) the lower part of the submaxillary gland; (2) the submaxillary lymph glands; (3) part of the external maxillary artery; (4) part of the anterior facial vein; (5) the mylo-hyoid nerve; (6) the mylo-hyoid artery; (7) a small part of the hypoglossal nerve; (8) a small part of the lingual vein.

Dissection.—Remove the deep fascia which was previously turned aside (p. 123) and clean the *submaxillary lymph glands*. Most of those glands lie immediately below the mandible, in the angle between it and the submaxillary gland, but some may be found on the superficial surface of the gland. Turn the gland upwards and fix it with hooks; then secure the *mylo-hyoid nerve and artery*, as they enter the posterior border of the anterior belly of the digastric about the middle of its length, and the twig which the nerve gives to the mylo-hyoid muscle. Define the band of fascia which surrounds the intermediate tendon of the digastric and binds it to the greater cornu of the hyoid bone. Note that the tendon is embraced by the cleft lower end of the stylo-hyoid muscle. Clean the posterior belly of the digastric and the stylo-hyoid muscle, which descends along its anterior border. Note that the posterior belly of the digastric and the stylo-hyoid disappear, postero-superiorly, under cover of the angle of the mandible. Clean the anterior belly of the digastric, and then examine the floor or medial boundary of the triangle. Immediately behind the anterior belly of the digastric it is formed by the posterior fibres of the mylo-hyoid muscle; and more posteriorly and on a deeper plane it is formed by the hyoglossus muscle (Figs. 51, 68).

Clean the portion of the mylo-hyoid which is exposed and, at its posterior border, immediately above the greater cornu of the hyoid bone, secure the *hypoglossal nerve* and the lingual vein; the vein lies below the nerve. Displace the lingual vein and the hypoglossal nerve upwards; cut through the fibres of the hyoglossus, immediately above and parallel with the greater cornu, and display the lingual artery, which in that position lies immediately above the greater cornu, parallel with the lingual vein but separated from it by the hyoglossus muscle.

All the structures which have been mentioned above will be met with in the dissection of other regions, when a full account of them will be given.

Turn next to the carotid triangle, so called because it contains parts of the common, internal, and external carotid arteries. It is bounded posteriorly by the anterior border of the sterno-mastoid; above and anteriorly by the posterior belly of the digastric; and below and anteriorly by the anterior belly of the omo-hyoid.

Dissection.—Trace the anterior facial vein from the digastric triangle, across the superficial surface of the posterior belly of the digastric, to the posterior border of the muscle, where it unites with the posterior facial vein, which is descending from under cover of the lower end of the parotid gland. The trunk formed by the union of the anterior and posterior facial veins is the *common facial vein.* Trace the common facial vein downwards and backwards to its union with the *internal jugular vein*, at or under cover of the anterior border of the sterno-mastoid. Remove the deep fascia and the areolar tissue, and the lymph glands which lie in the angle between the posterior belly of the digastric and the anterior border of the sterno-mastoid, below the lower end of the parotid gland; secure the lingual vein, which passes backwards from the tip of the greater cornu of the hyoid bone to join the internal jugular vein; and the hypoglossal nerve, as it crosses, at a higher level, superficial to the internal and external carotid arteries. As the nerve turns forwards across the large arteries it is itself crossed, superficially, by the sterno-mastoid branch of the occipital artery, and it gives off its *descending branch.* Trace the descending branch downwards, in the fascia which lies superficial to the lower part of the internal and the upper part of the common carotid arteries, to the point where it disappears under cover of the anterior belly of the omo-hyoid, avoiding injury to the lingual, common facial, and superior thyreoid veins;[1] and secure the *communicating branches,* from the second and third cervical nerves, which join its posterior aspect. The latter nerves may cross either superficial or deep to the internal jugular vein. Return to the hypoglossal nerve at the point where it gives off its descending branch, and trace it forwards to the upper aspect of the posterior end of the greater cornu of the hyoid bone, where it gives off the branch of supply to the thyreo-hyoid muscle. Trace the branch into that muscle, below the level of the greater cornu; then follow the trunk of the hypoglossal anteriorly to the digastric triangle. Note that as it runs forwards it passes deep to the posterior belly of the digastric and the stylo-hyoid muscle, and superficial to the hyoglossus, which ascends to the tongue from the upper border of the greater cornu. Remove the fascial sheath from the superficial surfaces of the lower parts of the *internal and external carotid arteries,* and from the upper part of the *common carotid artery.* Note that the latter divides into the two former at the level of the upper border of the thyreoid cartilage, and that the external carotid is at first medial and anterior to the internal carotid.

Five branches may spring from the external carotid artery in the carotid triangle—three from its anterior surface: the *superior thyreoid,* the *lingual* and the *external maxillary*; one from its medial surface, the *ascending pharyngeal*; and one from its posterior surface, the *occipital*; but not uncommonly the occipital and the external maxillary arise, beyond the limits of the carotid triangle, under cover of the posterior belly of the digastric. The superior thyreoid springs from the front of the lower part of the external carotid, below the level of the greater cornu of the hyoid, and runs downwards towards the lower angle of the carotid triangle, where it disappears under cover of the anterior belly of the omo-hyoid. The lingual arises about the level of the tip of the greater cornu. It runs forwards above the level of the cornu, forming a loop, convex upwards, which lies deep to the hypoglossal nerve; and it disappears under cover of the posterior border of the hyoglossus muscle. The ascending pharyngeal branch, which springs from the medial surface of the lower end of the external carotid, ascends on a deeper plane, between the external and internal carotids and the wall of the pharynx, and will be followed at a later stage of the dissection. The external maxillary and the occipital arise immediately below the posterior belly of the digastric and almost at once disappear under cover of the muscle; not uncommonly they arise under cover of its lower border. Before proceeding to

[1] The lingual vein may join the common facial vein, in which case the latter usually enters the internal jugular opposite the interval between the hyoid bone and the thyreoid cartilage, as in the specimen depicted in Fig. 12. The superior thyreoid vein either ends in the internal jugular or joins the common facial vein opposite the thyreo-hyoid interval.

clean the branches of the external carotid, secure the *internal and external laryngeal branches of the superior laryngeal branch of the vagus nerve.* The *internal* branch will be found in the posterfor part of the thyreo-hyoid interval below the greater cornu of the hyoid bone and behind the posterior border of the thyreo-hyoid muscle, beneath which it disappears. It is accom-

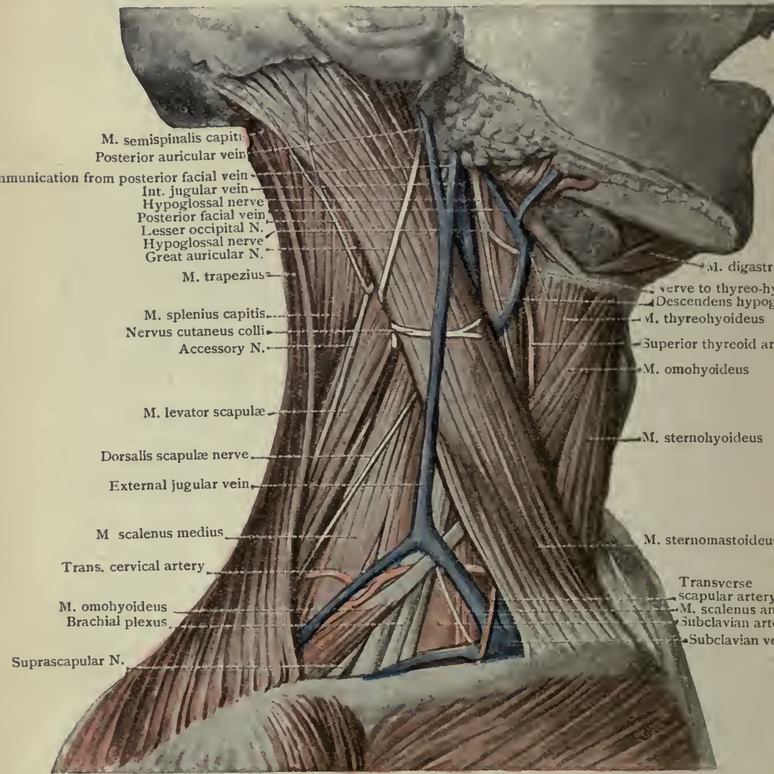


FIG 45.—The Triangles of the Neck seen from the side. The clavicular head of the sterno-mastoid muscle was small, and therefore a considerable part of the scalenus anterior muscle is seen.

panied by the *laryngeal branch of the superior thyreoid artery.* The external branch is more difficult to find ; but if the superior thyreoid artery and the upper part of the common carotid are displaced posteriorly, the nerve will be found, lying deep to them, in the fascia which covers the anterior part of the inferior constrictor muscle.

Remove the fascia from the surface of the internal jugular vein, which overlaps the anterior borders of the common and internal carotid arteries. Dissect in the interval between the vein and the arteries and secure the *vagus nerve*, which lies deeply.

Remove the remains of the fascia from the carotid arteries and the internal jugular vein, but avoid injury to the hypoglossal nerve and its branches; and note the presence of the *upper deep cervical lymph glands* which lie on the superficial surfaces of the great arteries and the internal jugular vein. The glands are sometimes very large, and the dissectors should remember that they receive lymph from the face, the mouth and tongue, the posterior part of the nose and the upper part of the pharynx. After the large vessels are cleaned, remove the fascia from the branches of the external carotid artery and the twigs they give off, so far as they lie in the region of the carotid triangle. Commence with the superior thyreoid. Immediately after its origin it gives off a small infrahyoid branch, then a laryngeal branch which accompanies the internal laryngeal branch of the superior laryngeal nerve; and, just before it disappears under cover of the anterior belly of the omo-hyoid, a sterno-mastoid branch arises from its posterior border and runs downwards and backwards, along the upper border of the omo-hyoid, across the superficial aspect of the common carotid artery and the internal jugular vein. Next, clean the lingual artery and note its small supra-hyoid branch. The external maxillary artery gives off no branches in the carotid triangle, but a sterno-mastoid branch of the occipital artery will usually be found passing downwards and backwards, superficial to the loop of the hypoglossal nerve. Push the lower border of the parotid gland upwards, and immediately under cover of it, at the level of the angle of the mandible, secure the *accessory nerve*, as it emerges from under cover of the posterior belly of the digastric and crosses superficial to the internal jugular vein. It is sometimes accompanied by an additional branch to the sterno-mastoid from the occipital artery.

The floor or medial boundary of the carotid triangle is formed by the upper part of the thyreo-hyoid muscle, the posterior part of the hyoglossus and the middle and inferior constrictors of the pharynx. The latter two muscles cannot be displayed at present, but the thyreo-hyoid is exposed below the greater cornu of the hyoid bone, and part of the hyoglossus can be seen in the angle between the greater cornu of the hyoid and the lower part of the posterior belly of the digastric.

The Muscular Triangle.—When the deep fascia which covers the muscular triangle is removed, portions of three muscles are brought into view. Postero-superiorly is the anterior belly of the omo-hyoid; more anteriorly and on the same plane is the sterno-hyoid; and below and anterior to the sterno-hyoid, but on a deeper plane, is a small part of the sterno-thyreoid.

The muscles mentioned may be considered to form the floor or medial boundary of the triangle, and, if this view is taken, the structures they cover, which lie more deeply, are under cover of the floor. Those structures must now be exposed.

Dissection.—Divide the anterior belly of the omo-hyoid along the anterior border of the sterno-mastoid and turn it upwards to its insertion into the hyoid bone. As that is done its twig of supply from the loop called the ansa hypoglossi will be cut. The *ansa hypoglossi* is formed by the union of the descending branch of the hypoglossal nerve and the communicating branch from the cervical plexus. Divide the sterno-hyoid as low down as possible ; turn it upwards to its insertion into the body of the hyoid bone and note its nerve of supply from the ansa hypoglossi. Secure the nerve to the sterno-thyreoid from the ansa hypoglossi ; then remove the fascia and expose the lower part of the thyreo-hyoid muscle, the greater part of the sterno-thyreoid and the anterior part of the thyreoid cartilage. Note that the sterno-thyreoid is inserted into an oblique line on the outer surface of the lamina of the thyreoid cartilage and that the thyreo-hyoid springs from the same line and is inserted into the greater cornu of the hyoid bone. The crico-thyreoid branch of the superior thyreoid artery may be found passing downwards and forwards along the upper end of the sterno-thyreoid, accompanied by the external laryngeal nerve ; or the nerve and the vessel may lie deep to the upper end of the muscle.

Divide the sterno-thyreoid as low down as possible and turn it upwards to its insertion ; remove the fascia under cover of it and expose the lobe of the thyreoid gland, enclosed in its fascial sheath. Below it, a small part of the side of the trachea will be seen.

The dissector should note that whilst the sterno-mastoid remains undisturbed the posterior part of the lobe of the thyreoid gland and its lower extremity are not exposed, but if the sterno-mastoid is displaced backwards the whole of the lateral surface of the lobe is brought into view. The dissector should note also that, until the sterno-mastoid is displaced backwards, only a small portion of the upper end of the common carotid and the lower parts of the internal and external carotid arteries are visible ; indeed, the common carotid may be entirely concealed. Only a small part of the anterior border of the internal jugular vein projects anterior to the sterno-mastoid in the upper angle of the carotid triangle ; and it also is not uncommonly hidden when the sterno-mastoid is well developed. During life, however, when the muscle is soft and pliable the structures concealed by it are readily exposed, for the muscle is easily displaced backwards after the fascia has been divided along its anterior border.

In dissecting-room subjects, in which the muscles have been hardened by formol, it is not possible to obtain a proper view of the course and relations of the common carotid artery and the internal jugular vein, or to appreciate the relations of the first part of the subclavian artery and the relations of the scalenus anterior muscle, until the sterno-mastoid has been reflected. Divide the external jugular vein immediately below its origin by the union of the posterior auricular vein with the communication from the posterior facial vein, and turn it downwards. Divide the great auricular nerve at the level of the angle of the mandible and turn it backwards; and turn backwards also the nervus cutaneus colli, whose two terminal branches have been cut already. The clavicular head of the sterno-mastoid was cut when the clavicle was removed; now divide the sternal head, turn the muscle upwards towards its insertion. As the muscle is turned upwards, sterno-mastoid branches of the transverse scapular, superior thyreoid, and occipital arteries will be exposed; and if they interfere with the reflection of the muscle they must be divided. Slightly above the level of the sterno-mastoid branch of the occipital artery the accessory nerve will be found passing through the deeper fibres of the muscle, and care must be taken to avoid injury to it; but it may be dissected out of the muscle and left in position on the lateral surface of the internal jugular vein.

Deep Cervical Fascia.—When the sterno-mastoid has been reflected, a deep fascial plane of the neck is exposed in which lie many lymph glands. Before carrying the dissection further the dissector should reconsider the arrangement of the deep cervical fascia. He has already seen that it forms a complete sheath enclosing the muscles of the neck and the structures which lie between and under cover of them. The general arrangement of the fascia is studied best on transverse sections of the neck made at the level of the isthmus of the thyreoid gland and a short distance above the sternum. At the former level it is possible to recognise (1) a superficial layer; (2) a pretracheal layer; (3) a prevertebral layer; and (4) a fascial sheath which encloses the common carotid arteries, the internal jugular vein and the vagus nerve, as they lie in the angular interval between the sterno-mastoid laterally, the thyreoid gland, the trachea, œsophagus medially, and the prevertebral muscles posteriorly.

The *first or superficial layer*, as it is traced backwards, splits to enclose the sterno-mastoid muscle (Fig. 47). Beyond the sterno-mastoid it passes backwards to the anterior border of the trapezius muscle, forming the roof of the posterior triangle; then it splits again to enclose the trapezius, along the surfaces of which it is prolonged till it blends with the supraspinous ligaments and the ligamentum nuchæ. The lamella which covers the deep surface of the sterno-mastoid is blended with the lateral surface of the carotid sheath. The *pretracheal layer*, which has been dissected already in the median plane, ensheaths the thyreoid gland and blends postero-laterally with the medial surface of the carotid sheath. The *prevertebral layer* covers the anterior surfaces of the prevertebral muscles, and, passing laterally, blends with the posterior aspect of the carotid sheath; then, turning round the tips of the transverse processes of the vertebræ, it passes backwards, covering the muscles which form the floor of the posterior triangle; and it becomes continuous with the sheaths of the deep muscles of the back of the neck.

Laterally and posteriorly, the superficial layer of the deep fascia passes upwards over the sterno-mastoid and the trapezius to be attached to the superior nuchal lines and the mastoid portions of the temporal bones. In the anterior cervical region it is attached to the body and the greater cornua of the hyoid bone, and then, as it is prolonged further upwards, it splits anteriorly to enclose the submaxillary gland, and posteriorly to enclose the parotid. It has been noted already that the lamella which passes superficial to the submaxillary gland is attached to the lower border of the mandible, and that which passes deep to the gland is connected above to the mylo-hyoid line on the inner surface of the mandible. The layer which passes superficial to the parotid gains attachment to the zygoma and is prolonged forwards to blend with the fascia covering the masseter. The lamella which passes deep to the parotid covers its postero-medial and antero-medial surfaces; the posterior part is attached above to the lower border of the tympanic plate, and the anterior part to the posterior border of the petro-tympanic fissure (O.T. Glaserian). It also gains an inter-

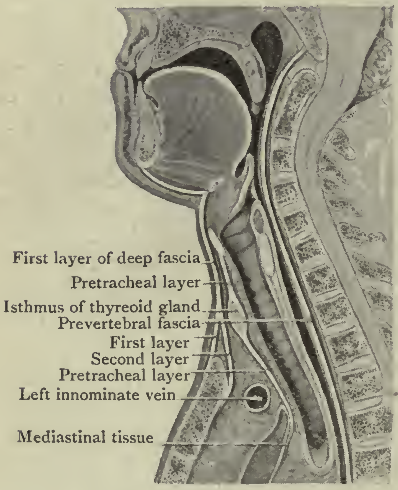


FIG. 46.—Diagram of deep Cervical Fascia in sagittal section.

mediate attachment to the styloid process and to the posterior border of the angle of the mandible. That portion is relatively thick; it lies in relation with the lower part of the antero-medial surface of the parotid and is known as the *stylo-mandibular ligament.*

When the superficial layer is traced downwards it is found to split, between the cricoid cartilage and the sternum, into two lamellæ. The more superficial of the two lies superficial to the sterno-mastoid and is attached, below, to the upper border of the sternum and the upper border of the clavicle. In the anterior region the deeper lamella descends upon the anterior surfaces of the infra-hyoid muscles and is attached, below, to the posterior surface of the manubrium; laterally, it passes deep to the sterno-mastoid and is fused with the lateral border of the carotid sheath. In the posterior triangle the deeper lamella ensheaths the posterior belly of the omo-hyoid and binds it down to the posterior border of the clavicle and the cartilage of the first rib. The space between the two lamellæ has been called the supra-sternal space. Its boundaries and contents have been fully described already (p. 122).

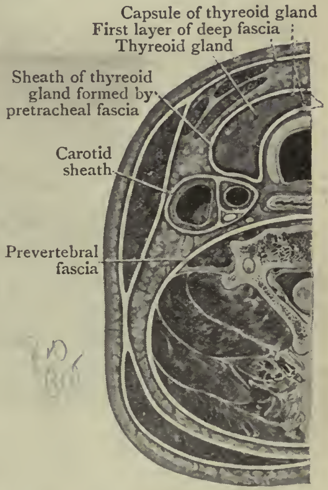


FIG. 47. — Diagram of deep Cervical Fascia in transverse section at the level of the thyreoid gland.

The upper attachment of the *pretracheal layer* is to the cricoid cartilage and to the laminæ of the thyreoid cartilage, below the insertion of the sterno-thyreoid muscle. At its lower end it blends with the fibrous pericardium in the middle mediastinum.

The *prevertebral layer* can be followed upwards to the base of the skull, where it is attached, in the anterior cervical region, to the posterior and medial margins of the jugular foramen and to the basilar part of the occipital bone, anterior to the insertions of the prevertebral muscles and posterior to the superior constrictor of the pharynx. Below, it blends with the fascia on the anterior aspect of the vertebral column in the posterior mediastinal region.

The Carotid Sheath.—The term carotid sheath is applied to the fascia which surrounds and embeds the carotid arteries, the internal jugular vein, and the vagus nerve. Part of it has been removed already, and the dissector will have noted that it is in no sense a membrane, but merely the fibro-areolar tissue which fills the interval between the transverse processes of the vertebræ posteriorly, the trachea, larynx, pharynx, œsophagus, and the lobe of the thyreoid gland medially, and the sterno-mastoid laterally; that it is continuous with the fascial planes in its immediate neighbourhood, and that

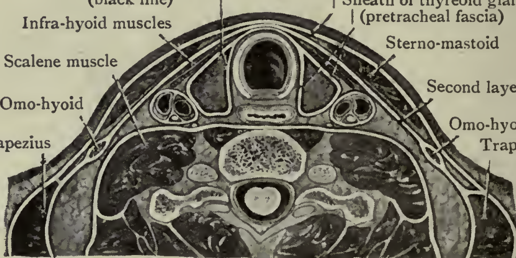


FIG. 48.—Diagram of the deep Cervical Fascia in a transverse section of the lower part of the neck.

through it run the carotid arteries, the internal jugular vein, and the vagus nerve, each in its own special compartment.

> ***Dissection.***—Remove the areolar tissue and the glands which lie under cover of the sterno-mastoid; stitch together the two parts of the divided anterior belly of the omo-hyoid muscle and fix the muscle to the common carotid artery and the internal jugular vein with one or two stitches; then proceed to display the structures which lie under cover of the sterno-mastoid. A glance at the following list will convince the dissector that they are very numerous.

Structures under cover of the Sterno-Mastoid.

Muscles.—The upper part of the splenius capitis; the upper and posterior part of the posterior belly of the digastric; the origins of the levator scapulæ, the scalenus medius, the longus capitis (O.T. rectus capitis anticus major), the rectus

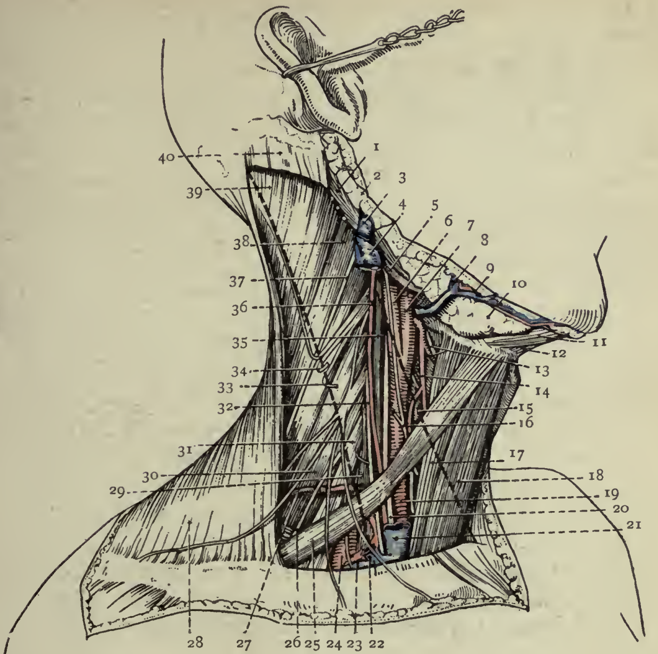


FIG. 49.—Dissection to show the structures under cover of the Sterno-Mastoid Muscle. The outline of the sterno-mastoid is indicated by the thick black broken lines. The greater part of the internal jugular vein has been removed to display the parts subjacent to it.

1. Digastric muscle (posterior belly).
2. Parotid gland.
3. Commencement of external - jugular vein.
4. Internal jugular vein.
5. Hypoglossal nerve.
6. Internal carotid artery.
7. External carotid artery.
8. Anterior facial vein.
9. Submental vessels.
10. Submaxillary gland.
11. Anterior belly of digastric muscle.
12. Mylo-hyoid muscle.
13. Laryngeal branch of superior thyreoid artery and internal laryngeal nerve.
14. Superior thyreoid artery.
15. Upper end of thyreoid gland.
16. Ansa hypoglossi.
17. Sterno-thyreoid muscle.
18. Sterno-hyoid muscle.
19. Common carotid artery.
20. Vagus nerve.
21. Internal jugular vein.
22. External jugular vein.
23. Subclavian vein below transverse scapular artery.
24. Subclavian artery.
25. Omo-hyoid muscle.
26. Long thoracic nerve.
27. First serration of serratus anterior muscle.
28. Trapezius muscle.
29. Scalenus anterior muscle.
30. Scalenus medius muscle.
31. Upper part of brachial plexus.
32. Phrenic nerve.
33. Nervus cutaneus colli.
34. Great auricular nerve.
35. Longus capitis muscle.
36. Ascending cervical artery.
37. Accessory nerve.
38. Levator scapulæ.
39. Splenius capitis muscle.
40. Sterno-mastoid muscle.

capitis lateralis and the scalenus anterior; the intermediate tendon of the omo-hyoid, and the lower and posterior part of the sterno-hyoid and sterno-thyreoid.

Arteries.—The upper part of the common carotid (the lower part is still concealed by the lower part of the omo-hyoid and the lower parts of the sterno-hyoid and sterno-thyreoid muscles); the transverse scapular and its sterno-mastoid branch; the transverse cervical; the sterno-mastoid branch of the superior thyreoid; the occipital and its sterno-mastoid branches.

Veins.—The greater part of the internal jugular vein; the lower transverse portion of the anterior jugular vein; and, occasionally, the lower end of the external jugular vein, when that vessel dips forwards to its termination.

Nerves.—The cervical plexus and its branches, including the phrenic nerve; part of the accessory nerve.

If the lower parts of the divided sterno-hyoid and sterno-thyreoid muscles are displaced downwards, the lower part of the common carotid and the commencement of the first part of the subclavian artery will be exposed. Crossing the front of the latter are the lower portion of the cervical part of the vagus and a strand of sympathetic fibres called the ansa subclavia; on the left side, the subclavian artery and the ansa are concealed by the commencement of the innominate vein. At the same time the middle thyreoid vein will be exposed, and the posterior border of the lobe of the thyreoid gland also.

Dissection.—Commence by cleaning the anterior rami of the cervical nerves, from the second to the eighth, as they emerge between the muscles attached to the tubercles of the transverse processes of the cervical vertebræ. The first nerve, which turns downwards anterior to the transverse process of the atlas, will be exposed later. As the upper nerves are cleaned the dissectors will find that the second is connected to the third, and the third to the fourth, by looped strands, convex posteriorly, which constitute the lower two loops of the cervical plexus. The second nerve is connected with the first also by a loop, convex anteriorly, which passes upwards anterior to the transverse process of the atlas and posterior to the upper part of the internal jugular vein. It can be exposed if the vein is pulled forwards; and the dissector must at the same time secure the twigs of connection which pass from the medial side of the loop to the hypoglossal nerve and to the superior cervical ganglion of the sympathetic trunk, which lies behind the upper part of the internal carotid artery.

After the dissector has defined the loops of the plexus he should trace the remains of the lesser occipital, the great auricular, the nervus cutaneus colli and the supraclavicular branches, which he displayed in the posterior triangle, to their origins from the roots of the plexus. The communicating branches which pass forwards to the descendens hypoglossi from the second, and sometimes also from the third cervical nerve, must be followed; they may cross either superficial or deep to the internal jugular vein. Then the phrenic nerve, which springs

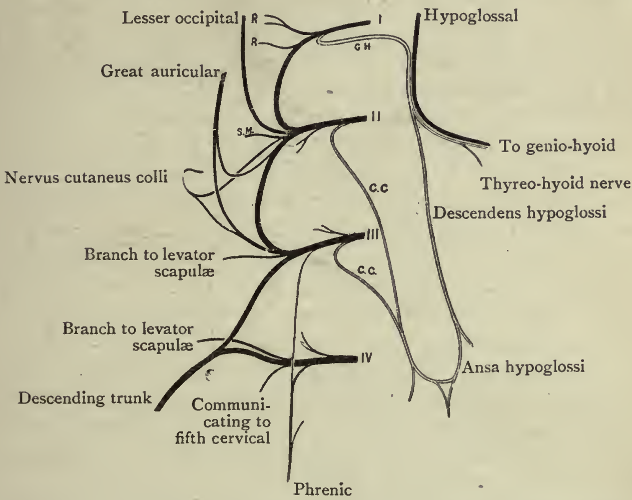


FIG. 50.—Diagram of the Cervical Plexus and the Ansa Hypoglossi.

I, II, III, IV.—Anterior rami of the upper four cervical nerves.

R. Branches to recti and longus capitis.
S.M. Branches to the sterno-mastoid.
C.C. Rami communicantes cervicales.
C.H. Communicating branch to hypoglossal.

This diagram shows that the descendens hypoglossi, the branch to the thyreo-hyoid, and in all probability the branches to the genio-hyoid, are composed of fibres given to the hypoglossal by the communicating twigs it receives from the first cervical nerve.

from the fourth cervical nerve, and receives additional twigs from the third and fifth nerves, must be followed downwards and medially, till it disappears under cover of the lower part of the internal jugular vein. It lies upon the surface of the scalenus anterior and passes deep to the omo-hyoid muscle and the transverse cervical and transverse scapular arteries. Running upwards parallel with, and anterior to it, is the ascending cervical branch of the inferior thyreoid artery.

Plexus Cervicalis.—The cervical plexus is a looped plexus formed by the first four cervical nerves. It lies in the upper part of the side of the neck, under cover of the sterno-mastoid. The upper loop of the plexus, which connects the first and second nerves together, is directed forwards and lies between the internal jugular vein anteriorly, and the transverse process of the atlas posteriorly. The second and third loops, which unite the second and third and the third and fourth nerves, are directed backwards; and they lie on the superficial surface of the upper part of the scalenus medius muscle. The first loop is connected with the upper ganglion of the sympathetic trunk and with the hypoglossal nerve; and the roots of the second, third, and fourth nerves also are connected, by grey rami, with the upper cervical sympathetic ganglion.

The branches of the plexus are divisible into two main groups, the superficial and the deep. *The deep branches* are separable into two groups: the anterior, which run forwards, and the posterior, which run backwards; and the *superficial branches* are classified as ascending, transverse, and descending.

The *anterior group of deep branches* includes: (1) The ramus communicans cervicalis (p. 131), and (2) the phrenic nerve. (3) Less important muscular branches, from the first loop to (*a*) the rectus capitis lateralis; (*b*) the rectus capitis anterior (O.T. rectus capitis anticus minor); (*c*) the longus capitis (O.T. rectus capitis anticus major). (4) Muscular branches, from the third and fourth nerves, to the longus colli.

The *posterior group of deep branches* is formed by: (1) The communicating branches to the accessory nerve. (2) Branches of supply to: (*a*) the sterno-mastoid, from the second nerve; (*b*) the levator scapulæ, from the third and fourth; (*c*) the trapezius, from the third and fourth; (*d*) the scalenus medius, from the second, third, and fourth.

The *ascending group of superficial branches* is formed by the lesser occipital and great auricular nerves. The *transverse branch* is the nervus cutaneus colli; and the *descending branches* are the supraclavicular nerves. All the superficial nerves have already been traced in the earlier stages of the dissection (pp. 34, 35). The small muscular branches require no special notice, but the phrenic nerve requires careful consideration.

Nervus Phrenicus.—The importance of the phrenic nerve depends upon the fact that it is the nerve of supply to the chief muscle of respiration, the diaphragm. The majority of its fibres spring from the fourth cervical nerve, but it receives

PLATE VI

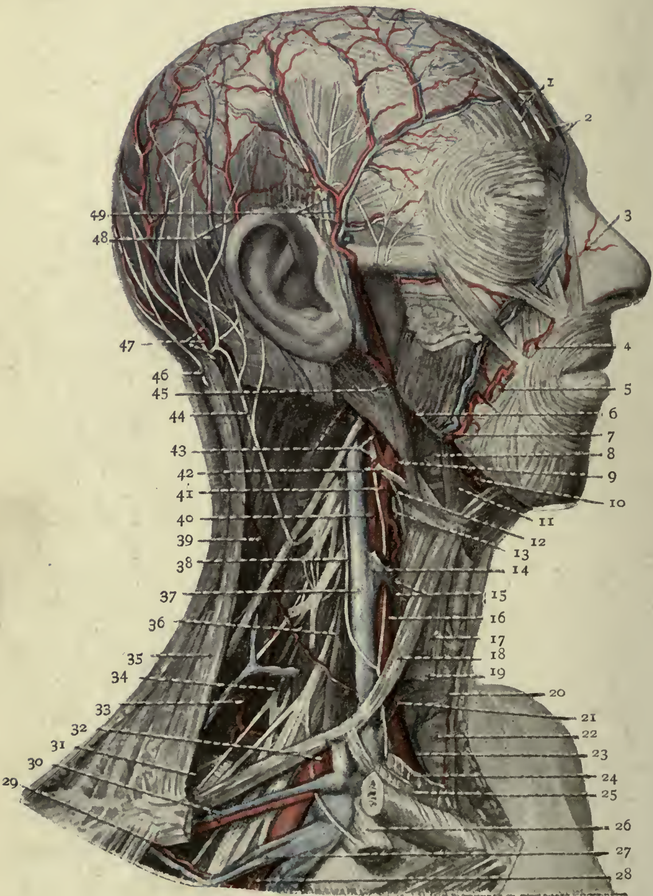


FIG. 51.

PLATE VI

FIG. 51.—Dissection of the Head and Neck of the same subject as that shown in Fig. 15, but the greater part of the parotid gland, the greater part of the sterno-mastoid muscle, the greater part of the external jugular vein, portions of other veins, portions of the sterno-hyoid and sterno-thyreoid muscles, and the submaxillary gland have been removed to display deeper structures.

1. Supra-orbital artery and nerve.
2. Frontal artery and vein.
3. Lateral nasal branch of external maxillary artery.
4. Superior labial branch of external maxillary artery.
5. Inferior labial branch of external maxillary artery.
6. External maxillary artery.
7. External maxillary artery.
8. Deep part of submaxillary gland.
9. Lingual artery.
10. Submental branch of external maxillary artery.
11. Mylo-hyoid muscle.
12. Nerve to thyreo-hyoid muscle.
13. Internal laryngeal nerve.
14. Common facial vein.
15. Superior thyreoid vessels.
16. Common carotid artery and descendens hypoglossi nerve.
17. Sterno-hyoid muscle.
18. Omo-hyoid muscle (anterior belly).
19. Sterno-thyreoid muscle.
20. Thyreoid gland.
21. Middle thyreoid vein.
22. Trachea.
23. Inferior thyreoid vein.
24. Sterno-thyreoid muscle.
25. Sterno-hyoid muscle.
26. Subclavius muscle with nerve.
27. Cephalic vein.
28. Lateral anterior thoracic nerve.
29. Acromial branch of thoraco-acromial artery.
30. Transverse scapular vessels.
31. First serration of serratus anterior muscle.
32. Subclavian artery.
33. Transverse cervical artery.
34. Upper root of long thoracic nerve.
35. Trapezius.
36. Scalenus anterior.
37. Internal jugular vein.
38. Communicans hypoglossi nerve.
39. Ascending branch of transverse cervical artery.
40. Internal carotid artery.
41. External carotid artery.
42. Hypoglossal nerve.
43. Occipital artery and sterno-mastoid branch.
44. Lesser occipital nerve.
45. Digastric and stylo-hyoid muscles.
46. Third occipital nerve.
47. Greater occipital nerve and occipital artery.
48. Posterior auricular artery and vein.
49. Superficial temporal vessels and auriculo-temporal nerve.

twigs from the third and, not uncommonly, from the fifth nerve also. It descends from the neck through the superior and middle mediastinal regions of the thorax, and, after piercing the diaphragm, it is distributed on its lower surface. Only the cervical portion of the nerve belongs to the dissector of the neck; the remainder is displayed by the dissector of the thorax (p. 43, Vol. II.). In the neck, the nerve runs downwards and medially, on the superficial surface of the scalenus anterior, which forms its deep relation. It is covered by skin, superficial fascia and platysma, deep fascia and the sterno-mastoid; deep to the sterno-mastoid, it is overlapped by the internal jugular vein, and it is crossed by the omo-hyoid, the anterior jugular vein, and the transverse cervical and transverse scapular arteries; in addition, the left nerve is crossed by the thoracic duct, and the right nerve by the right lymph duct. At the root of the neck it passes from the medial border of the anterior scalene to the anterior surface of the first part of the subclavian artery; on the right side it crosses the artery, on the left it descends in front of it; it is covered anteriorly, on both sides, by the clavicle and by the commencement of the innominate vein; and it crosses either anterior or posterior to the internal mammary artery. It gives off no branches in the neck, but it sometimes receives a communication from the nerve to the subclavius.

After the dissector has completed the examination of the formation, the relations, and the branches of the cervical plexus, he should replace the divided infra-hyoid muscles in position and study their attachments and relations.

The **Infra-hyoid Muscles** are a series of flat, band-like muscles which lie upon the trachea, thyreoid gland, and larynx. They are disposed in two strata—viz., the omo-hyoid and the sterno-hyoid constituting a superficial layer; and the sterno-thyreoid and thyreo-hyoid a deep layer.

Musculus Omohyoideus.—The omo-hyoid is a two-bellied muscle. The *posterior belly* springs from the upper border of the scapula and the upper transverse scapular ligament. It crosses the posterior triangle of the neck, dividing it into occipital and subclavian portions, and terminates, under cover of the sterno-mastoid muscle, in an intermediate tendon. The muscle is superficial to the brachial plexus, and the tendon is superficial to the phrenic nerve and the scalenus anterior. The tendon is held in position by a strong process of cervical fascia which is firmly attached below to the sternum and the first costal cartilage. The *anterior belly* emerges from under cover of the anterior border of the sterno-mastoid, and takes an almost vertical course through the anterior triangle. It is inserted into the lower border of the body of the hyoid bone, at the lateral side of the sterno-

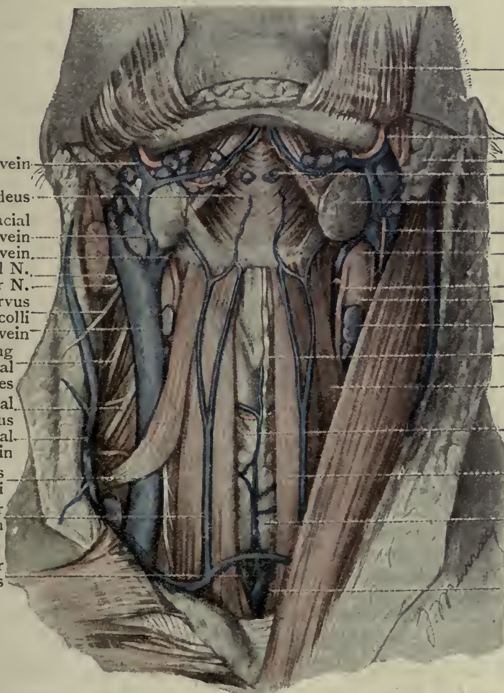


FIG. 52.—Dissection of the Front of the Neck. The right sterno-mastoid has been removed.

hyoid. In the anterior triangle of the neck it forms the boundary between the carotid and the muscular subdivisions, and it lies superficial to the internal jugular vein, the common carotid artery, the descendens hypoglossi, the superior thyreoid artery, the external laryngeal nerve, the attachments of the sterno-thyreoid and thyreo-hyoid muscles to the lamina of the thyreoid cartilage; and immediately below its insertion it covers part of the thyreo-hyoid membrane. Both bellies are supplied by branches from the *ansa hypoglossi.* Acting from the scapula it pulls the hyoid bone downwards and slightly backwards.

Musculus Sternohyoideus.—The sterno-hyoid muscle arises from the posterior aspect of the medial end of the clavicle, the posterior sterno-clavicular ligament, and the posterior surface of the manubrium sterni. It is inserted into the lower border of the body of the hyoid bone, between the median plane and the insertion of the omo-hyoid. A short distance above the sternum an oblique tendinous intersection frequently divides it into two portions. The lower part of the muscle is covered by the sterno-mastoid, and it is crossed by the anterior jugular vein. Its principal deep relations are the lower part of the common carotid artery and the sterno-thyreoid muscle, which separates it from the lateral lobe of the thyreoid gland. It is supplied by branches from the *ansa hypoglossi.* It pulls the hyoid bone downwards.

Musculus Sternothyreoideus.—The sterno-thyreoid muscle lies under cover of the preceding and is broader but shorter. It springs from the posterior aspect of the manubrium sterni and from the cartilage of the first rib. Diverging slightly from its fellow as it ascends, it is inserted into the oblique line on the lateral face of the lamina of the thyreoid cartilage, parallel with and immediately below the thyreo-hyoid. An incomplete tendinous intersection may sometimes be noticed interrupting its muscular fibres. In the neck, it is covered in the greater part of its extent by the sterno-hyoid; but the posterior part of its insertion is covered by the anterior belly of the omo-hyoid; and the lower and anterior part is covered by skin and fascia only. The nerve supply is derived from the *ansa hypoglossi.* It pulls the thyreoid cartilage downwards.

Musculus Thyreohyoideus.—The thyreo-hyoid muscle lies on the same plane as the sterno-thyreoid, and may be regarded as its upward continuation. It takes origin from the oblique line on the lateral surface of the lamina of the thyreoid cartilage, and is inserted into the lower border of the greater cornu of the hyoid bone, under cover of the omo-hyoid muscle. It conceals part of the lamina of the thyreoid cartilage and the lateral part of the thyreo-hyoid membrane, and the aperture in the membrane through which the laryngeal branch of the superior thyreoid artery and the internal laryngeal nerve enter the pharynx. It is supplied by a twig from the *hypoglossal nerve.* It approximates the hyoid bone to the thyreoid cartilage.

Dissection.—The dissectors of the head and neck should now proceed to study the relations of the common carotid and subclavian arteries, the cervical part of the thoracic duct, and the dome of the pleura, before those structures are disturbed by the dissectors of the thorax. Whilst this is being done, the omohyoid must be retained in position, but the upper and lower portions of the other infra-hyoid muscles may be turned upwards and downwards respectively.

Remove the remains of the fascial sheath from around the common carotid artery and the adjacent part of the internal jugular vein.. Separate the vein from the artery, and clean the portion of the vagus nerve which lies between them on a posterior plane. Note that, on the right side, the nerve crosses the anterior surface of the subclavian artery, and there gives off its recurrent branch ; and that, on the left side, it lies medial to the subclavian artery, and in an anterior plane.

After the lower parts of the cervical portions of the vagi have been cleaned, look for the terminal part of the thoracic duct, on the left side, and for the right lymph duct, on the right side. In seeking for the thoracic duct, pull the lower end of the left internal jugular vein aside and displace the common carotid artery forwards ; then look for the duct, as it turns laterally from the border of the œsophagus, a little below the level of the cricoid cartilage ; trace it, posterior to the internal jugular vein, to its termination in the commencement of the innominate vein. On the right side, look for the right lymph duct entering the innominate vein in the angle of union of the internal jugular and subclavian veins. Next, look for the cervical portion of the sympathetic trunk, which descends posterior to the common carotid. Clean the nerve trunk carefully and clean also the inferior thyreoid artery, which crosses anterior or posterior to it, at the level of the cricoid cartilage. Displace the common carotid laterally, and in the angle between the borders of the trachea and the œsophagus find the recurrent branch of the vagus ; trace it upwards to the point where it disappears under cover of the lobe of the thyreoid gland, and downwards to the subclavian artery.

Arteria Carotis Communis.—The common carotid artery arises differently on the two sides. On the right side, it arises as a terminal branch of the innominate artery, behind the sterno-clavicular joint ; on the left side, it springs from the aortic arch, in the superior mediastinum. The left artery ascends to the back of the left sterno-clavicular articulation. From the sterno-clavicular joint each common carotid artery runs upwards, backwards, and slightly laterally to the level of the upper border of the thyreoid cartilage, which lies opposite the fibro-cartilage between the third and fourth cervical vertebræ; there it ends by dividing into its two terminal branches—the internal and the external carotid arteries.

Superficial Relations.—Above the level of the anterior belly of the omo-hyoid the common carotid artery is covered by the skin, the superficial fascia and the platysma, the deep fascia and the anterior margin of the sterno-mastoid. It is crossed, immediately above the omo-hyoid, by the sterno-mastoid branch of the superior thyreoid artery, and, at a higher level, by the superior thyreoid vein; and it is overlapped by the anterior margin of the internal jugular vein. In the lower part of its extent it lies more deeply: its superficial relations are,—the skin and superficial fascia, the deep fascia

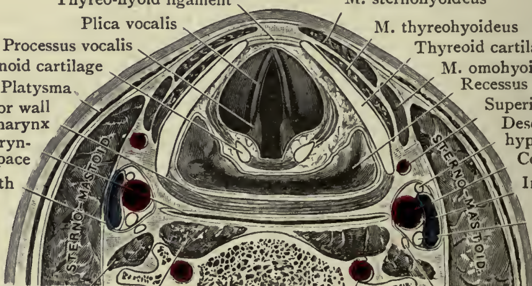


FIG. 53.—Transverse section through the Neck at the level of upper part of Thyreoid Cartilage.

and the sterno-mastoid; the anterior jugular vein, crossing transversely, deep to the sterno-mastoid and above the upper border of the clavicle; the omo-hyoid, the sterno-hyoid, and the sterno-thyreoid muscles. Deep to the muscles, the branches of the *ansa hypoglossi* descend in front of its sheath; and the middle thyreoid vein crosses it to join the internal jugular vein (Fig. 51).

Posterior to it lie the transverse processes of the cervical vertebræ and the origins of the longus colli, longus capitis and the scalenus anterior. The sympathetic trunk is directly behind it, and the vagus is postero-lateral to it. The inferior thyreoid artery crosses posterior to it, at the level of the cricoid cartilage; and the vertebral artery lies between it and the transverse process of the seventh cervical vertebra. On the right side, the recurrent nerve crosses posterior to it, immediately above its origin; and on the left side, the thoracic duct turns laterally behind it, between it and the vertebral artery.

To its medial side, below, lie the trachea and œsophagus, with the recurrent nerve in the angle between their adjacent borders; and to the medial side of its upper part are the larynx and pharynx. The lobe of the thyreoid gland lies either medial to the artery, separating it from the œsophagus, pharynx, trachea, and larynx, or it forms a direct anterior relation (Figs. 48, 53). Between its upper extremity and the inferior constrictor muscle of the pharynx lies the glomus caroticum.

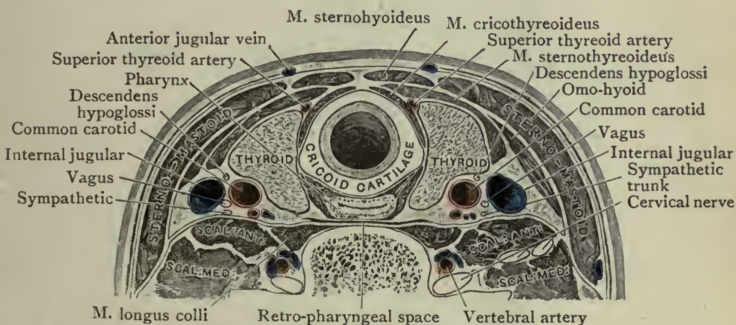


FIG. 54.—Transverse section through the Neck at the level of the Cricoid Cartilage.

As a rule, the terminal divisions are the only branches of the common carotid, but occasionally the superior thyreoid or the ascending pharyngeal artery arises from it, instead of from the external carotid. That is more especially the case when the division of the common carotid takes place at a higher level than usual.

Glomus Caroticum.—The glomus caroticum is a little, oval, reddish-brown body, placed upon the deep aspect of the common carotid artery at the point where it bifurcates. To expose it, therefore, the vessel must be twisted round in such a manner that its posterior surface is turned forwards. It is closely connected with the sympathetic filaments which twine around the carotid vessels; and in structure it is similar in its nature to the glomus coccygeum, which rests upon the anterior aspect of the coccyx. It is included, therefore, in the group of ductless glands. Entering it are numerous minute arterial twigs, which take origin from the termination of the common carotid and the commencement of the external carotid. The function of the remarkable little body is quite unknown, but it belongs to the system of chromophil organs.

Arteria Subclavia.—The relations of the third part of the

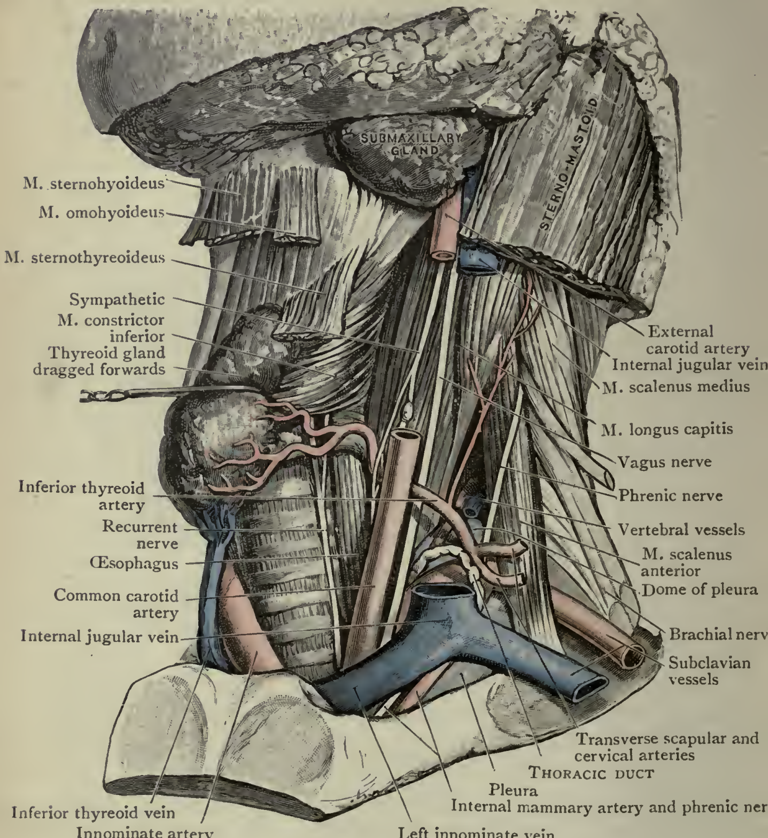


FIG. 55.—Deep Dissection of the Root of the Neck on the Left Side to show the Dome of the Pleura and the relations of the Terminal Part of the Thoracic Duct. The sterno-mastoid and the depressors of the hyoid and larynx have been removed.

subclavian artery were examined during the dissection of the posterior triangle (p. 37). The relations of the first and second parts must now be studied. On the right side, a small portion of the first part is already exposed between the lower end of the internal jugular vein and the common carotid artery; the remainder can be seen if the internal jugular vein is drawn aside. On the left side, the first part of the artery is concealed by the commencement of the innominate vein, which must be pushed aside. On both sides, the second part of the artery lies posterior to the scalenus anterior, which must be left in position.

The subclavian artery is the first portion of the great arterial trunk which carries blood for the supply of the upper extremity. It arises differently on the two sides of the body. On the *right side*, it takes origin, behind the sterno-clavicular joint, as a terminal branch of the innominate artery. On the *left side*, it arises from the aortic arch, in the superior mediastinum. In both cases, it takes an arched course laterally across the root of the neck, posterior to the scalenus anterior and on the anterior surface of the cervical dome of pleura, a short distance below its summit. At the outer border of the first rib it becomes the axillary artery.

For descriptive purposes the artery is divided into three parts. The *first part* extends from the origin of the vessel to the medial margin of the scalenus anterior; the *second portion* lies posterior to that muscle; and the *third part* extends from the lateral border of the scalenus anterior to the outer border of the first rib.

First Part.—Owing to the difference of origin, the relations of the first portion of the subclavian artery are not the same on the two sides of the body. The first part of the *right subclavian* extends obliquely upwards and laterally, and at its termination at the medial margin of the scalenus anterior it has reached a point above the level of the clavicle. It is placed very deeply. Anteriorly, it is covered by the skin, superficial fascia, platysma, deep fascia, and three muscular strata—viz., the clavicular origin of the sterno-mastoid, the sterno-hyoid, and the sterno-thyreoid. Three veins and some nerves are placed anterior to it. At the medial margin of the scalenus anterior it is crossed by the internal jugular and vertebral veins, whilst the anterior jugular vein, as it passes laterally under cover of the sterno-mastoid, is separated from it by the sterno-hyoid and sterno-thyreoid muscles. The nerves which cross anterior to it are the vagus, a loop from the sympathetic (ansa subclavia), and in some cases cardiac branches of the vagus and sympathetic as they run to the thorax. At the lower margin of the artery the vagus nerve gives off its recurrent branch.

The cervical dome of the pleura is both below and posterior

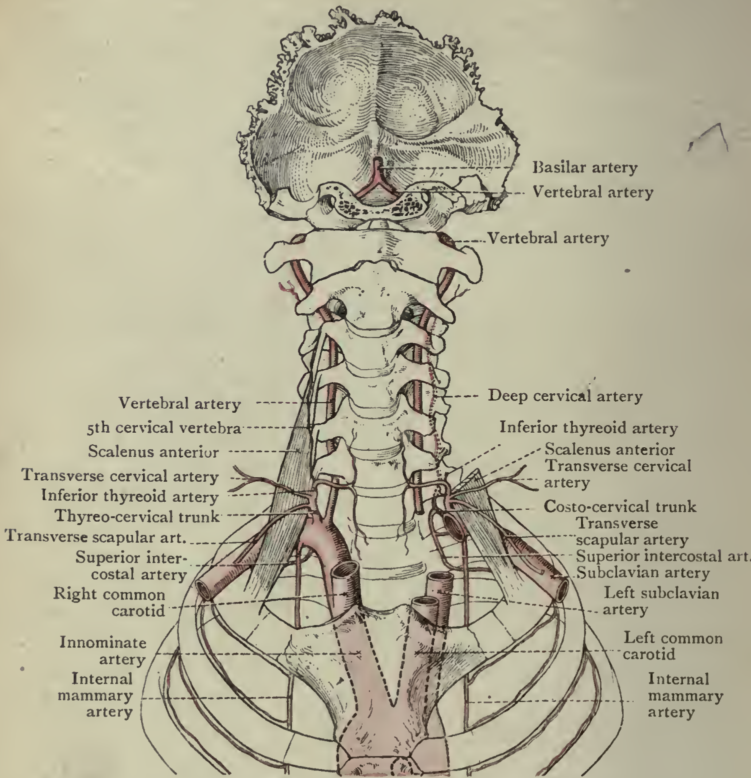


FIG. 56.—Diagram of Subclavian Arteries and their branches.

to the artery, and the recurrent branch of the vagus nerve hooks round below and ascends posterior to it.[1]

On the *left side*, the first part of the subclavian ascends almost vertically from its origin from the aortic arch, and,

[1] If the lung has been removed by the dissector of the thorax the lower and posterior relations should be verified by examination from the thoracic side.

reaching the root of the neck, it curves laterally across the dome of the pleura to the medial margin of the scalenus anterior. The relations of the cervical part are somewhat different from those on the right side. The same fascial and muscular layers, and the same nerves and veins, are anterior to it. Owing to its different direction, however, the nerves and veins are placed more or less parallel to it. Three additional relations are established—viz., the phrenic nerve and the left innominate vein lie anterior to it; and the thoracic duct first passes upwards in relation to its medial or right side, and then arches over it to reach the angle of junction between the subclavian and internal jugular veins (Fig. 55).

The recurrent nerve on the left side hooks round the arch of the aorta, and lies to the medial side of the subclavian artery.

Second Part.—The second portion of the subclavian artery forms the highest part or summit of the arch, and rises from half an inch to an inch above the level of the clavicle.

In that part of its course the vessel has not so many superficial relations. *Anteriorly*, it is covered by—(1) skin; (2) superficial fascia and platysma; (3) deep fascia; (4) clavicular head of the sterno-mastoid; (5) scalenus anterior. The phrenic nerve on the right side is also an anterior relation, but it is separated from the artery by the medial margin of the scalenus anterior. *Posteriorly and inferiorly*, the vessel is in relation with the pleura, Sibson's fascia intervening. The subclavian vein lies at a lower level than the artery and on an anterior plane, and is separated from it by the scalenus anterior.

The *third part* of the subclavian artery is described on p. 41.

Branches of the Subclavian Artery.—Four branches spring from the subclavian trunk (Fig. 56). Three take origin, as a general rule, from the first part of the artery, and one from the second part. They are—

From the *first part.*	1. Vertebral.	
	2. Thyreo-cervical.	Inferior thyreoid. Transverse cervical. Transverse scapular.
	3. Internal mammary.	
From the *second part.*	Costo-cervical.	Superior intercostal. Deep cervical.

In a great number of cases a branch of considerable size springs from the third part of the subclavian artery. In some cases it is the descending branch of the transverse cervical, which then arises directly from the subclavian. In other cases it is the transverse scapular artery.

Arteria Vertebralis.—The vertebral artery is the first branch of the subclavian. It springs from the upper and posterior aspect of the trunk, about 6.2 mm. (a quarter of an inch) from the medial margin of the scalenus anterior, on the right side, and from the point where the vessel reaches the root of the neck, on the left side. Only a small portion of it is seen in the present dissection. It proceeds upwards, in the interval between the longus colli and the scalenus anterior muscles, posterior to the common carotid, and disappears into the foramen transversarium of the sixth cervical vertebra. It is placed very deeply, and is covered anteriorly by its companion vein and the common carotid artery. Numerous large sympathetic twigs accompany it.

The vertebral artery on the *left side* is posterior to the internal jugular vein and the common carotid artery, and it is crossed by the thoracic duct.

The *vertebral vein* issues from the aperture in the transverse process of the sixth cervical vertebra. It passes downwards, antero-lateral to its companion artery, and posterior to the internal jugular vein, to open into the posterior aspect of the commencement of the corresponding innominate vein. Near its termination it crosses the subclavian artery. It receives the *deep cervical* and the *anterior vertebral veins.*

Truncus Thyreocervicalis (O.T. **Thyroid Axis**).—The thyreo-cervical trunk is a short wide vessel, which arises from the anterior aspect of the subclavian artery, close to the medial margin of the scalenus anterior, and under cover of the internal jugular vein. It lies between the phrenic and vagus nerves, and almost immediately breaks up into its three terminal branches—viz., the inferior thyreoid, the transverse scapular, and the transverse cervical.

Arteria Thyreoidea Inferior.—The inferior thyreoid artery takes a sinuous course to reach the thyreoid gland. First, it ascends for a short distance along the medial border of the scalenus anterior, and under cover of the internal jugular vein; then, at the level of the cricoid cartilage, it turns suddenly medialwards and passes posterior to the vagus, the sympathetic, and the common carotid artery, to reach the posterior border of the thyreoid gland. There it gives off branches to the pharynx and larynx, and then descends along the posterior border of the thyreoid gland, distributing branches to its substance and to the trachea and the œsophagus.

The following branches will be noticed arising from the inferior thyreoid artery:—

1. Ascending cervical.	5. Œsophageal.
2. Inferior laryngeal.	6. Glandular.
3. Tracheal.	7. Muscular.
4. Pharyngeal.	

Arteria Cervicalis Ascendens.—The ascending cervical artery (Fig. 51) is a small but constant vessel which runs upwards, in the interval between the scalenus anterior and longus capitis, and gives branches to the muscles in front of the vertebral column. It also gives off *spinal branches*, which enter the vertebral canal upon the spinal nerves, and anastomose with branches from the vertebral artery. The ultimate distribution of the spinal branches has been noticed already (p. 79).

Arteria Laryngea Inferior.—The inferior laryngeal artery is a small vessel which accompanies the recurrent nerve to the larynx.

The *tracheal*, *œsophageal*, and *pharyngeal branches* supply the trachea, the gullet, and the pharynx. They are of small size, and anastomose with the bronchial and œsophageal branches of the thoracic aorta. The *glandular branches* are usually two in number. One ascends upon the posterior aspect of the corresponding lobe of the thyreoid gland, whilst the other is given to its base or lower end. They inosculate with the corresponding vessels of the opposite side, and also with the branches of the superior thyreoid artery. The *muscular branches* are a series of irregular twigs given to neighbouring muscles.

Venæ Thyreoideæ Inferiores.—The inferior thyreoid veins do not run in company with the arteries of the same name. Each is a comparatively large vessel which comes from the corresponding lobe and the isthmus of the thyreoid gland, and descends upon the trachea under cover of the sterno-thyreoid muscle. The veins of both sides enter the thorax, and frequently unite to form a short common stem, which opens into the left innominate vein. In other cases, however, the right vein opens separately into the angle of union between the two innominate veins. Both veins, as they proceed downwards, receive tributaries from the larynx, trachea and œsophagus.

The *anterior vertebral vein* accompanies the ascending cervical artery, and opens into the vertebral vein as it issues from the foramen transversarium of the sixth cervical vertebra.

Arteriæ Transversæ Scapulæ et Colli.—The transverse scapular and the transverse cervical arteries have already been examined in the greater part of their courses (p. 34). After taking origin from the thyreo-cervical trunk, they both pass laterally, across the scalenus anterior muscle and the phrenic nerve, under cover of the clavicular head of the sterno-mastoid. The *transverse scapular* crosses the anterior scalene muscle close to its insertion, immediately above the subclavian vein; the *transverse cervical* is placed at a slightly higher level.

The *transverse scapular* and *transverse cervical veins* have already been seen joining the external jugular vein (p. 40).

Arteria Mammaria Interna.—The internal mammary artery springs from the lower and anterior aspect of the subclavian, directly below the thyreo-cervical trunk. It passes downwards to reach the thorax, lying upon the anterior surface of the pleura, and posterior to the medial end of the clavicle and the medial end of the subclavian vein. As it lies posterior to the subclavian vein the phrenic nerve passes from its lateral to its medial side, either anterior or posterior to it. In the neck the internal mammary artery is not accompanied by a vein.

Truncus Costocervicalis.—On the right side the costocervical trunk takes origin from the posterior aspect of the second portion of the subclavian artery, close to the medial border of the scalenus anterior. To bring it into view the subclavian artery must be dislodged from its position. On the left side, however, it proceeds, as a rule, from the first part of the parent trunk. It is a short trunk which passes upwards and backwards, over the apex of the pleura, to the neck of the first rib, where it divides into the *deep cervical artery* and the *superior intercostal artery*.

If the lung is removed from the thorax, the dissector should take the opportunity of examining this artery from the thoracic aspect.

Arteria Cervicalis Profunda.—The deep cervical artery passes dorsally, and disappears from view between the transverse process of the seventh cervical vertebra and the neck of the first rib. It has been already noticed in the dissection of the back of the neck (p. 67).

The *deep cervical vein* is a large vessel. It joins the vertebral vein.

Arteria Intercostalis Suprema.—The superior intercostal artery turns downwards, anterior to the neck of the first rib, between the first thoracic nerve and the first thoracic ganglion of the sympathetic trunk. It gives a posterior intercostal branch to the first space and ends as the posterior intercostal artery of the second space (Fig. 56).

Vena Subclavia.—The subclavian vein is the continuation of the axillary vein into the root of the neck. It begins at the outer border of the first rib, and arches medially across the anterior surface of the lower end of the scalenus anterior. At the medial margin of that muscle, and posterior to the sternal end of the clavicle, it unites with the internal jugular vein to form the innominate vein. In connection with the subclavian vein note: (1) that the arch which it forms is not so pronounced as the arch of the corresponding artery; (2) that throughout its whole course it lies at a lower level, and upon a plane anterior to the artery; and (3) that it is separated from the artery by the scalenus anterior and the phrenic nerve. In the whole of its course the vein lies posterior to the clavicle.

The sheath of the subclavian vein is attached to the posterior surface of the costo-coracoid membrane. The relation is of some practical importance; for, on account of it, a forward movement of the clavicle drags upon the vein, and in cases where the vessel is wounded there is always a danger of air being sucked into the vein by such a movement.

The *tributary* of the subclavian vein is the external jugular vein, which joins it at the lateral margin of the scalenus anterior.

Ductus Thoracicus et Ductus Lymphaticus Dexter.—The *thoracic duct* is the vessel by means of which the chyle, and the lymph derived from by far the greater part of the body, are poured into the venous system on the left side (p. 147). Its terminal or cervical portion is displayed in the dissection of the neck. It is a small, thin-walled vessel, frequently mistaken for a vein, which enters the root of the neck at the left margin of the œsophagus. It is there that it should be sought for. At the level of the seventh cervical vertebra it arches laterally and forwards, and then downwards, above the apex of the pleura, and it enters the innominate vein in the angle of the union of the internal jugular vein with the

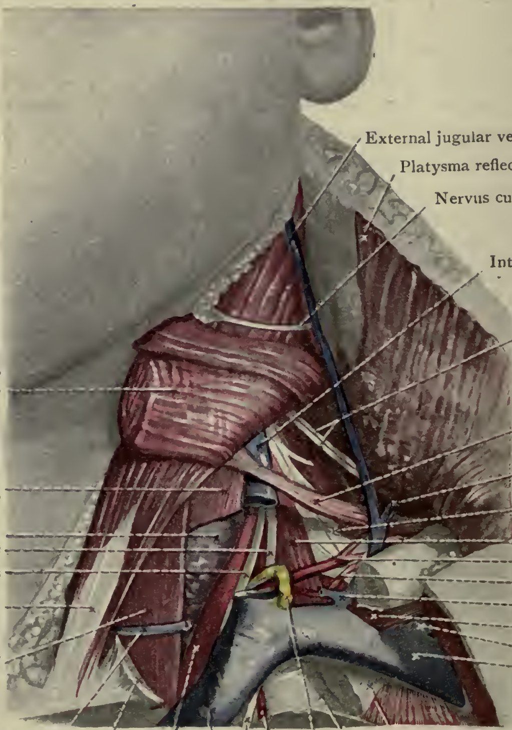


FIG. 57.—Deep Dissection of the Root of the Neck on the Left Side to show the Dome of the Pleura and the relations of the Terminal Part of the Thoracic Duct. Parts of the sterno-mastoid and the sterno-thyreoid have been removed.

subclavian. As the thoracic duct courses laterally it lies at a higher level than the subclavian artery, and passes posterior to the common carotid artery, the vagus nerve, and the internal jugular vein; and anterior to the vertebral artery and vein and the thyreo-cervical trunk or its inferior thyreoid branch;

and as it runs downwards to its termination it is separated from the scalenus anterior by the transverse cervical and transverse scapular arteries and the phrenic nerve. Further, as it approaches the point at which it ends, it lies anterior to the first part of the subclavian artery (Figs. 55, 56).

A valve composed of two semilunar segments guards its entrance into the innominate vein.

The *right lymph duct* is the corresponding vessel on the right side, but it is a comparatively insignificant channel which conveys lymph from a much more restricted area. It commences in the root of the neck, where it is formed by the union of the broncho-mediastinal trunk with the subclavian and jugular lymphatic trunks of the right side. It terminates in the commencement of the innominate vein by opening into it in the angle of union of the subclavian and internal jugular veins. As in the case of the thoracic duct, its orifice is guarded by a double valve. Through the broncho-mediastinal trunk it receives lymph from the intercostal glands which lie in the upper intercostal spaces of the right side, and from the thoracic visceral lymph glands of the right side; and, through the right subclavian and jugular lymph trunks, lymph is poured into it from the right upper extremity and the right side of the head and neck, respectively. It constitutes, therefore, the main lymph drain for the following districts: (1) right upper limb; (2) right side of the head and neck; (3) upper part of right thoracic wall; (4) right side of diaphragm and upper surface of liver; (5) thoracic viscera on right side of median plane, viz., right side of the heart and pericardium and the right lung and pleura. But not uncommonly the broncho-mediastinal, the right jugular and subclavian lymph trunks open separately into the internal jugular, the subclavian or the innominate vein.

Cervical Pleura.—The pleural sac of each side, with the apex of the corresponding lung, projects upwards into the root of the neck, and the dissector should now examine the height to which it rises, and the connections which it establishes. Its height, with reference to the first pair of costal arches, varies in different subjects. In some cases it extends upwards for two inches above the sternal end of the first rib; in others, for not more than one inch. The differences depend on the degree of obliquity of the thoracic inlet.

Posteriorly, in the majority of cases, the apex of the pleura corresponds, in level, with the neck of the first rib. It forms a dome-like roof for each side of the thoracic cavity, and is strengthened by a fascial expansion (frequently termed *Sibson's fascia*), which covers it completely, and is attached, on the one hand, to the transverse process of the seventh cervical

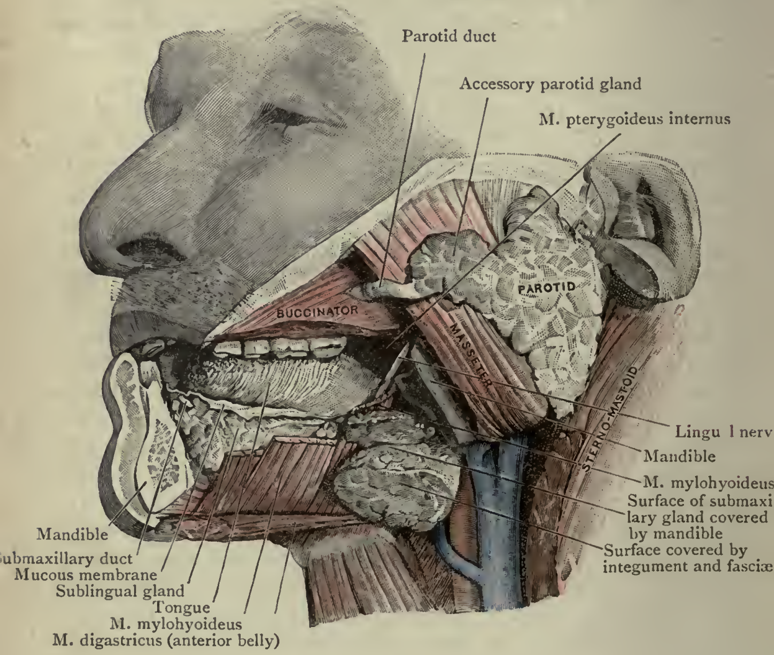


FIG. 58.—Dissection of the Parotid, Submaxillary, and Sublingual Glands.

vertebra, and, on the other, to the inner margin of the first rib.

Note that it is in relation with: (1) the scalenus anterior; (2) the scalenus medius; (3) the subclavian artery; (4) the vertebral artery; (5) the costo-cervical trunk; (6) the superior intercostal artery; (7) the internal mammary artery; (8) the innominate vein; (9) the vertebral vein; (10) the subclavian vein; (11) the vagus nerve; (12) the phrenic nerve; (13) the recurrent nerve, on the right side; (14) the first thoracic nerve; (15) the first thoracic ganglion of the sympathetic; (16) the ansa subclavia (Vieussenii).

The scalenus anterior covers the antero-lateral part of the dome, separating it from the subclavian vein, which ends at the medial border of the muscle. Immediately above the vein the subclavian artery crosses the dome, below its apex. The internal mammary artery descends from the subclavian, passes posterior to the subclavian vein, and is crossed, as it lies behind the vein, by the phrenic nerve, which passes in some cases anterior to, and in others posterior to the artery. The costo-cervical trunk ascends from the subclavian and crosses the apex of the dome; its superior intercostal branch descends, posterior to the apex, between the first intercostal nerve on the lateral side, and the first thoracic sympathetic ganglion on the medial side. The vagus nerve descends anterior to the medial part of the subclavian artery, and, on the right side, its recurrent branch turns round the lower border of the artery; the ansa subclavia lies to the lateral side of the recurrent nerve.

PAROTID REGION.

It is not possible to examine the relations of either the whole of the internal jugular vein or the external carotid artery, or the whole of the cervical portion of the internal carotid, until the parotid gland has been removed, the infra-temporal and submaxillary regions have been dissected, and the posterior belly of the digastric and the styloid process have been detached and displaced forwards. It is important, however, that the internal jugular vein should be retained in position whilst those parts of the dissection are being proceeded with; the dissector should therefore stitch the subclavian vein to the anterior surface of the scalenus anterior, and the lower part of the internal jugular vein to the first part of the subclavian artery, before proceeding to the study and removal of the parotid gland.

Glandula Parotis.—The parotid gland is wedged into a more or less triangular interval, the *parotid space*, which is bounded anteriorly by the posterior borders of the masseter, the ramus of the mandible, and the internal pterygoid, and postero-medially by the anterior border of the sterno-mastoid, the mastoid process, the posterior belly of the digastric, the styloid process, and the stylo-hyoid muscle. The space extends upwards to the external acoustic meatus, and it is prolonged downwards into the carotid triangle, into which the lower extremity of the gland descends, for a short distance, beyond the angle of the mandible. The gland, however, is more extensive than the space and passes for a varying distance forwards, beyond the anterior border of the

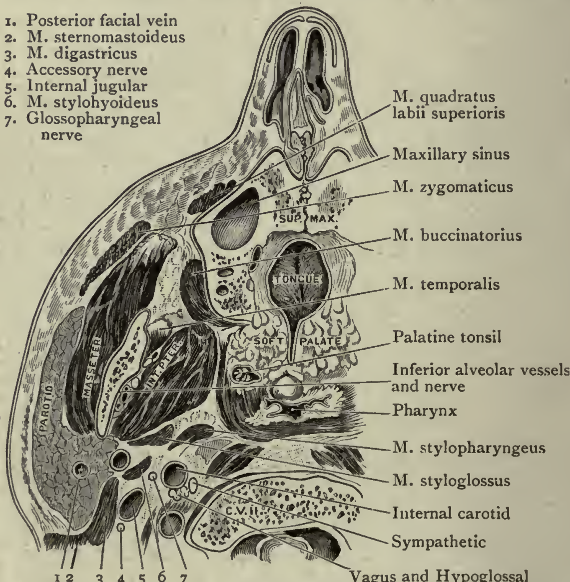


FIG. 59.—Transverse section through the Head at the level of the Hard Palate. It shows the relations of the parotid gland, etc.

space, over the superficial surface of the masseter (Figs. 4, 58).

In accordance with the position which it occupies the gland may be described as possessing four surfaces, two extremities, and four borders. The surfaces are superficial or lateral, postero-medial, antero-medial, and superior; the extremities, upper and lower; the borders, anterior, posterior, medial, and superior. The medial border separates the antero-medial from the postero-medial surface. The anterior and posterior borders separate the lateral surface from the antero-medial and postero-medial surfaces, respectively. The upper border circumscribes the upper surface and intervenes between it and the other three surfaces.

The *superficial surface* is irregular in outline (Figs. 4 and 60). It is covered by skin, superficial fascia, platysma and risorius, and deep fascia. Embedded in it are a few superficial parotid lymph glands, which receive lymph from the anterior part of the scalp, from the face, above the level of the mouth, and from the lateral surface of the auricle. Posteriorly, it is in relation with the mastoid process and the anterior

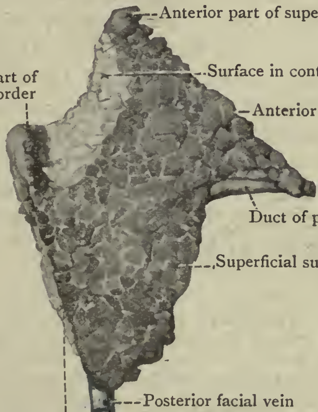


FIG. 60.—Parotid Gland, lateral view.

border of the sterno-mastoid muscle. Above, it touches the posterior part of the lower border of the zygoma and the lower surface of the external meatus.

From beneath the part in contact with the zygoma emerge the auriculo-temporal nerve, the temporal branches of the facial nerve, and the superficial temporal artery, on their way to the scalp; and the posterior facial vein disappears under cover of it. Its lower extremity, which is wedged between the angle of the mandible and the anterior border of the sterno-mastoid, is usually in contact with one of the upper deep cervical glands, whilst the cervical branch of the facial nerve, the posterior facial vein, and a communication to the external jugular vein emerge from it; the former two pass downwards and forwards, and the latter one passes downwards and backwards.

From under cover of the anterior border, which rests upon the masseter, the duct of the gland (Stensen's), the transverse facial artery, and the zygomatic, buccal, and mandibular branches of the facial nerve pass forwards; and the transverse facial vein disappears under cover of it.

The *duct of the parotid gland* (Stensen's), after appearing from under cover of the anterior border of the gland, runs forwards, across the masseter, at the level of a line drawn from the lobule of the auricle to a point situated midway between the red margin of the upper lip and the ala of the nose. At the anterior border of the masseter it turns inwards, at right angles to its former course, and after piercing the sucking pad of fat, the buccinator fascia, the buccinator muscle and the mucous membrane of the vestibule of the mouth, it opens into the vestibule, on the apex of a papilla, opposite the second molar tooth of the maxilla.

Immediately in front of the anterior border of the gland, below the zygoma and above the duct, lies a small separated portion of the gland substance called the *accessory parotid*; its duct opens into the main duct.

Dissection.—The gland must be removed piecemeal as the structures which pass through it are dissected out. The facial nerve and its branches are the most superficial structures in the substance of the parotid; therefore they must be dissected first. Trace the terminal branches backwards into the gland until they join the main divisions, which are the *upper* and the *lower*. The temporal and zygomatic branches spring from the upper division; the buccal, mandibular, and cervical spring from the lower division. Follow the divisions backwards, across the posterior facial vein, to their union with the trunk of the nerve, which pierces the postero-medial surface of the gland; then trace the trunk, across the root of the styloid process, to the stylo-mastoid foramen, and secure the branch which springs from it to supply the posterior belly of the digastric and the stylo-hyoid muscles, and the posterior auricular branch. As the trunk of the nerve is being cleaned the posterior auricular branch of the external carotid artery will probably be exposed, passing upwards and backwards, along the upper border of the posterior belly of the digastric, to the back of the external meatus, and crossing either superficial or deep to the nerve. Next, remove the deeper parts of the gland and expose the posterior facial vein, descending towards the angle of the mandible. It receives the transverse facial and the internal maxillary veins, and it gives off a communicating branch to the external jugular vein; then it passes out of the lower end of the gland and unites with the anterior facial vein to form the common facial vein. Deep to the veins will be found the upper end of the external carotid artery dividing into its superficial temporal and internal maxillary branches;

and the transverse facial and middle temporal offsets of the superficial temporal will also be displayed.

When the remains of the deeper part of the gland have been removed, the styloid process with the origin of the stylo-hyoid muscle, and the posterior belly of the digastric will be exposed ; and the internal jugular vein and the internal and external carotid arteries will be seen disappearing under cover of the digastric. If the occipital artery lies at its lower level, it also will be noted as it runs upwards and backwards, along the lower border of the digastric, crossing superficial to the two large vessels, and to the accessory nerve, which emerges from under cover of the digastric and passes downwards and backwards across the internal jugular vein.

The dissector should now obtain a gland which has been removed uninjured from the parotid space, or a cast of a gland, and proceed to study the relations of the upper end and the postero-medial and antero-medial surfaces.

The *upper surface* presents a deep concavity which is usually separable into a larger lateral part which lies in contact with the cartilaginous part of the external meatus, and a smaller medial part which touches the bony wall of the meatus (Fig. 61). The anterior boundary of the upper end forms a sharp ridge, which lies in the narrow interval between the capsule of the mandibular articulation and the front of the external meatus.

The *postero-medial surface* is marked by a series of depressions which correspond with the structures in the postero-medial boundary of the parotid space. Above is a shallow depression corresponding with the anterior border of the mastoid process, and, below the latter, a groove caused by the anterior border of the sterno-mastoid. More medially is a shallow depression due to the posterior belly of the digastric and the stylo-hyoid, and, still more medially and at a higher level, a sulcus which corresponds with the position of the styloid process. Below the level of the digastric groove the postero-medial surface covers portions of the internal jugular vein and the internal and external carotid arteries (Fig. 61). The communication to the external jugular vein, the posterior facial vein, and the cervical branch of the facial nerve emerge from that part of the surface. Immediately above the digastric groove, close to the medial border, the external carotid artery enters the gland ; and, directly lateral to the upper end of the groove for the styloid process, the facial nerve passes into the gland substance (Fig. 62). The dissector should note that the postero-medial surface of the gland is separated from the upper parts of the internal jugular vein and the internal carotid artery, and from the last four cerebral nerves by the posterior belly of the digastric, the styloid process and the muscles attached to it.

The *medial border* of the gland lies in the angle between the postero-medial and the anterior boundaries of the parotid space, where the styloid process, the stylo-hyoid muscle, and the posterior belly of the digastric disappear under cover of the posterior border of the internal pterygoid muscle; and

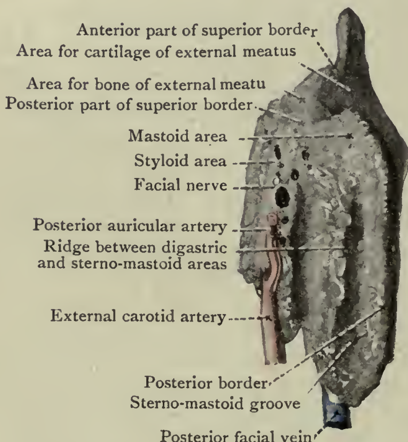


FIG. 61.—Parotid Gland, postero-medial aspect.

from it a process, *the pterygoid lobe*, usually projects forwards, for a short distance, between the internal pterygoid and the medial surface of the ramus of the mandible. Through the base of that process the external carotid passes from the postero-medial to the antero-medial surface of the gland.

The antero-medial surface.—The medial part of the antero-medial surface is directed forwards and lies in relation with the lower part of the posterior border of the internal pterygoid, the stylo-mandibular ligament, and the posterior border of the ramus of the mandible. The more lateral part is directed medially and rests against the lateral surface of the masseter. The antero-medial surface is pierced (1) by the external carotid artery, (2) the posterior facial and the internal maxillary veins, (3) all the terminal branches of the facial nerve except the cervical, and (4) by the duct of the gland.

As the dissector examines the parotid space he will note that as the external carotid disappears under cover of the posterior belly of the digastric it is placed so far forwards that it is also under cover of the posterior border of the mandible; and it does not emerge from under cover of the mandible until it reaches the level of the neck of the bone, where it appears on the antero-medial surface of the gland and divides into its two terminal branches. Further, he will now readily recognise the impossibility of studying

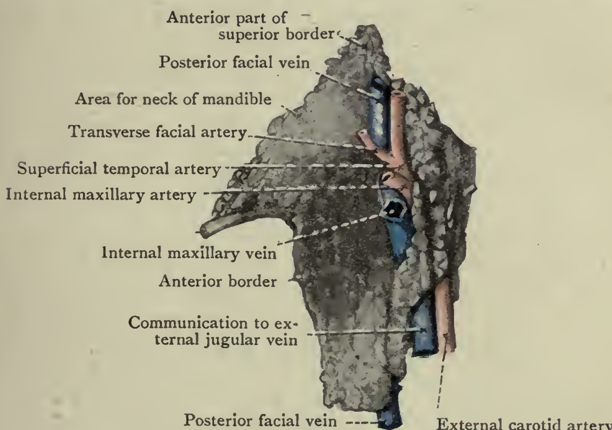


FIG. 62.—Parotid Gland, antero-medial aspect.

the upper end of the cervical part of the internal carotid, the upper part of the internal jugular vein, and the last four cerebral nerves, until he is in a position to reflect the posterior belly of the digastric and the styloid process; and as both of them are, to a certain extent, under cover of the mandible it is obvious that the mandible must be removed. That will be done during the dissection of the temporal and infratemporal regions, which must now be proceeded with.

TEMPORAL AND INFRATEMPORAL REGIONS.

Fascia Temporalis.—The temporal fascia is a strong, glistening membrane which is stretched over the temporal fossa, binding down the temporal muscle. Its upper margin is attached to the upper temporal line on the lateral aspect of the parietal bone, and anteriorly to the temporal line of the frontal bone. As it approaches the zygomatic arch, it splits into two laminæ, which are separated from each other by a narrow interval filled with fat. The two laminæ are attached one to the upper border of the zygomatic arch and the posterior border of the zygomatic bone, and the other to the medial surfaces of those two portions of bone. They can readily be demonstrated by dividing the superficial layer close to its attachment, and throwing it upwards; by the handle of the knife the attachment of the deep layer can then be made out. In the upper part of its extent, the temporal fascia is comparatively thin and the fibres of the subjacent muscle may be seen shining through it; below, it is thicker, and owing to the fat which is interposed between its laminæ, it is perfectly opaque. It is pierced immediately above the posterior part of the zygomatic arch by the middle temporal branch of the superficial temporal artery and by the middle temporal vein (p. 48).

Musculus Masseter.—The masseter is a thick quadrate muscle which covers the ramus of the mandible. Its fibres are arranged in two sets—a superficial and a deep. The *superficial part* of the muscle arises from the anterior two-thirds of the lower border of the zygomatic arch, and its fasciculi are directed downwards and backwards. The *deep part* springs from the whole length of the medial aspect of the zygomatic arch, and also from the posterior third of its lower border. Its fibres proceed downwards. Only a small piece of the upper and posterior part of the latter portion appears on the surface. The masseter is inserted into the lateral surface of the ramus of the mandible, over an area which extends downwards to the angle, and upwards so as to include the lateral aspect of the coronoid process. The masseter raises the mandible and helps to protract it. The deeper fibres which run downwards and forwards when the mandible is protracted help to retract the protracted bone. The nerve of supply is derived from the mandibular division of the trigeminal nerve.

Dissection.—Turn the upper part of the posterior margin of the masseter forwards and secure its nerve and artery of supply which pass to it through the incisura mandibularis, behind the tendon of the temporal muscle. To display the temporal muscle, make the following dissection. Divide the deep part of the temporal fascia along the upper border of the zygomatic arch and remove it. The middle temporal artery and the zygomatico-temporal nerve, which pierce it, must be disengaged from it and preserved. Divide the zygomatic arch, behind and in front of the masseter, and throw the arch, with the attached masseter, downwards. As that is being done cut the artery and nerve of supply out of the masseter muscle, leaving a small portion of the muscular substance attached to them so that they may be identified at later stages of the dissection. First make use of the saw, and then complete the division by means of the bone forceps. The posterior cut should be made immediately anterior to the articular tubercle which lies in front of the mandibular (O.T. glenoid) fossa and the head of the mandible; the anterior cut must extend obliquely through the zygomatic bone, from the extreme anterior end of the upper margin of the arch, downwards and forwards to the point where the lower margin meets the zygomatic process of the maxilla. When the division is completed, and the nerve and artery to the masseter are detached, the whole arch and the attached masseter may be readily thrown downwards towards the angle of the mandible. The fleshy origin of the deep portion of the masseter from the medial surface of the zygomatic arch can then be seen. The dissection is frequently complicated by a number of fibres from the temporal muscle joining the deep part of the masseter. Leave the masseter attached to the angle of the mandible, and clean the temporal muscle.

Musculus Temporalis.—The temporal muscle is fan-shaped. It arises from the whole extent of the temporal fossa, from the lower temporal line to the infratemporal crest on the great wing of the sphenoid. It receives additional fibres also from the deep surface of the temporal fascia. From their broad origin the fasciculi converge towards the coronoid process of the mandible. The anterior fibres descend vertically, the posterior fibres at first pursue a nearly horizontal course, whilst the intermediate fasciculi proceed with varying degrees of obliquity. A tendon is developed upon its superficial aspect, near its insertion, and the tendon is inserted into the summit and anterior edge of the coronoid process. The deep part of the muscle remains fleshy, and gains insertion to the medial surface of the coronoid process by an attachment which reaches as low down as the point where the anterior margin of the ramus merges into the body of the mandible. The insertion cannot be fully examined at present; it will be dealt with later. The temporal muscle raises the mandible and retracts it. It is supplied by a branch of the mandibular division of the trigeminal nerve.

Dissection.—Detach the coronoid process from the mandible, and turn it upwards with the attached temporal muscle. A very oblique cut is required ; it should extend from the centre of the incisura mandibulæ above, downwards and forwards, to the point where the anterior margin of the ramus meets the body of the mandible. First use the saw, and then complete the division with the bone forceps. The *buccinator nerve* (O.T. *long buccal*) and its companion *artery* are in a position of danger during this dissection, and must be carefully guarded. They proceed downwards and forwards, under cover of the lower part of the temporal muscle, and not infrequently the nerve traverses the substance of the muscle. The coronoid process and the temporal muscle must be thrown well upwards, and the muscular fibres must be separated, by the handle of the knife, from the bone forming the lower part of the temporal fossa, in order that *deep temporal nerves* and *arteries* may be exposed, as they ascend between the cranial wall and the muscle. At this stage the *middle temporal artery* will also be exposed as it extends upwards upon the squamous part of the temporal bone. If it is injected branches will be found passing from it to the temporal muscle. The zygomatico-temporal nerve should now be traced to the point where it emerges from the minute aperture on the temporal surface of the zygomatic bone. At that point it lies under cover of the temporal muscle.

The infratemporal region (O.T. pterygo-maxillary) may now be fully opened up by removing a portion of the ramus of the mandible. Two horizontal cuts must be made—one through the neck of the mandible, and the other immediately above the level of the mandibular (O.T. inferior dental) foramen. To find the level of the foramen, thrust the handle of the knife between the ramus and the subjacent soft parts, and carry it downwards. Its progress will soon be arrested by the entrance of the inferior alveolar vessels and nerve into the foramen, and the lower border of the instrument will correspond with the line along which the bone should be cut. Both incisions should be made with the saw, until the lateral table of the bone is cut through, and then the bone forceps may be employed to complete the division. Lastly, remove the fat and areolar tissue.

When the fat and areolar tissue are removed, the pterygoid muscles will come into view. The *external pterygoid* extends backwards to the neck of the mandible. The *internal pterygoid*, embracing the anterior part of the external pterygoid muscle between its two heads of origin, proceeds downwards and backwards upon the deep surface of the ramus of the mandible. The great blood vessel of the space—the *internal maxillary artery* —passes forwards upon (frequently under cover of) the lower head of the external pterygoid muscle. The *nerves* of the region also will be found in close relationship to the same muscle. Emerging from between its upper border and the cranial wall, at the level of the infratemporal crest, are the *masseteric* and the *posterior deep temporal nerves* posteriorly, and the *anterior deep temporal nerve* anteriorly ; appearing from under cover of its lower border are the *inferior alveolar nerve*, which descends to the alveolar foramen of the mandible, and more anteriorly the *lingual nerve* ; whilst emerging between the two heads of the external pterygoid is the *buccinator nerve*. The *spheno-*

mandibular ligament also will be seen. It is the thin strip of membrane which lies medial to the inferior alveolar nerve.

Musculus Pterygoideus Externus.—The external pterygoid arises in the infratemporal fossa by two heads, an upper and a lower. The *upper head*, which is the smaller, springs from the infratemporal ridge and infratemporal surface of the great wing of the sphenoid; the *lower head* takes origin from the

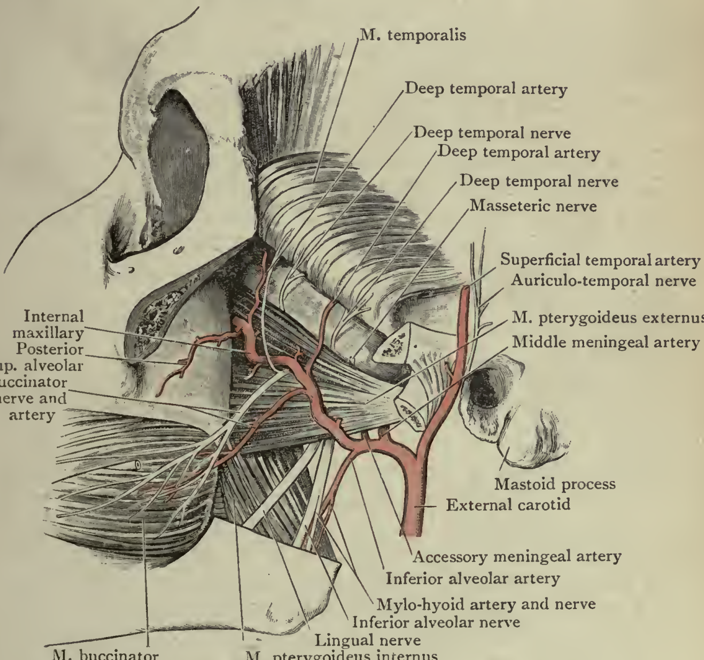


FIG. 63.—Dissection of the Infratemporal Region.

lateral surface of the lateral pterygoid lamina. The muscle diminishes in width as it passes backwards, and it is inserted into the fovea on the anterior surface of the neck of the mandible, and also into the capsule of the mandibular articulation at the level of the anterior margin of the articular disc of the joint. It protrudes and depresses the mandible and pulls it towards the opposite side. It is supplied by a branch of the mandibular division of the trigeminal nerve.

Musculus Pterygoideus Internus.—The internal pterygoid also is bicipital at its origin, and its two heads embrace the origin of the lower head of the external pterygoid. The *superficial* and smaller *head* of the internal pterygoid springs from the lower and posterior part of the tuberosity of the maxilla behind the last molar tooth, and also from the adjoining lateral surface of the pyramidal process (O.T. tuberosity) of the palate bone; the *deep head*, hidden by the external pterygoid, arises in the pterygoid fossa from the medial surface of the lateral pterygoid lamina, and from the posterior surface of the pyramidal process of the palate bone which appears between the two pterygoid laminæ. The two heads of the muscle unite at the lower margin of the anterior part of the external pterygoid, and the fibres proceed downwards with a postero-lateral inclination, and gain insertion into the angle of the mandible, and into the lower and posterior part of the medial aspect of the ramus as high as the mandibular foramen. The internal pterygoid raises the mandible, protrudes it, and pulls it towards the opposite side. It is supplied by a branch of the mandibular division of the trigeminal nerve.

Arteria Maxillaris Interna.—The internal maxillary artery is the larger of the two terminal branches of the external carotid artery. It takes origin immediately posterior to the neck of the mandible and passes forwards to the anterior part of the infratemporal fossa, where it disappears from view by dipping between the two heads of origin of the external pterygoid muscle and entering the pterygo-palatine fossa. It is divided into three parts, for convenience of description. The *first part* runs, horizontally, between the neck of the mandible and the spheno-mandibular ligament. It lies along the lower border of the posterior part of the external pterygoid muscle, and usually crosses the inferior alveolar nerve superficially. The *second part* extends obliquely upwards and forwards upon the lateral surface of the lower head of the external pterygoid muscle, under cover of the insertion of the temporal muscle. The *third part* dips between the two heads of the external pterygoid into the pterygo-palatine fossa (Fig. 63).

The arrangement described is that most frequently found, but it is not uncommon to find the second part of the artery lying in a deeper plane, viz. between the internal and external pterygoid muscles. In that case the vessel makes a bend laterally, between the heads of the external pterygoid muscle before entering the pterygo-palatine fossa.

The *branches* of the internal maxillary artery are classified according to the portion of the vessel from which they spring. Only one branch of the third part, viz. the *posterior superior alveolar artery*, can be studied in this dissection. Those arising from the first and second parts are:—

FROM THE FIRST PART.	FROM THE SECOND PART.
1. Arteria auricularis profunda. 2. Arteria tympanica. 3. Arteria meningea media. 4. Ramus meningeus accessorius. 5. Arteria alveolaris inferior.	1. Arteria masseterica. 2. Rami pterygoidei. 3. Arteriæ temporales profundæ. 4. Arteria buccinatoria.

Arteria Auricularis Profunda.—The deep auricular artery is a small vessel which pierces the anterior wall of the external acoustic meatus to supply the skin which lines the meatus, and also the superficial part of the tympanic membrane.

Arteriæ Meningea Media et Tympanica Anterior.—The middle meningeal and the anterior tympanic branches pass upwards under cover of the external pterygoid muscle, and, therefore, cannot be fully studied until that muscle is reflected.

Arteria Alveolaris Inferior.—The inferior alveolar artery arises opposite the middle meningeal, and runs downwards, along the lateral surface of the spheno-mandibular ligament, to enter the mandibular foramen. It is generally accompanied by two venæ comites, and it is placed posterior to the inferior alveolar nerve. Just before entering the foramen, the inferior alveolar artery gives off the slender *mylo-hyoid branch*, which runs downwards and forwards, with the corresponding nerve, upon the deep aspect of the mandible, to the digastric triangle of the neck.

The branches from the second part are given off for the supply of the neighbouring muscles. The *Masseteric* passes horizontally, posterior to the temporal muscle, with the nerve of the same name, and has been seen entering the masseter muscle. The *Pterygoid Branches* are irregular twigs to the pterygoid muscles. The *Deep Temporal Branches* are two in number—*anterior* and *posterior*; they pass upwards in the temporal fossa, between the bony wall of the cranium and the temporal muscle. They supply twigs to the temporal muscle, and they anastomose with the middle temporal artery. The *Buccinator Branch* accompanies the buccinator nerve, and is distributed to the buccinator muscle and the mucous membrane of the cheek. It anastomoses with the external maxillary (O.T. facial) artery.

Arteria Alveolaris Superior Posterior.—The posterior superior alveolar branch from the third part of the internal maxillary artery, descends upon the posterior aspect of the maxilla, and sends branches through the alveolar canals of the maxilla for the supply of the upper molar and præmolar teeth (Fig. 63). Some small twigs go to the gum, and others supply the lining membrane of the maxillary sinus.

Plexus Pterygoideus et Vena Maxillaris Interna.—The veins of the infratemporal region are very numerous, but they cannot be studied satisfactorily in an ordinary dissection. They constitute a dense plexus, termed the *pterygoid plexus*, around the external pterygoid muscle. Tributaries corresponding to the branches of the internal maxillary artery open into the network, whilst the blood is led away from its posterior part by a short wide trunk, called the *internal maxillary vein.*[1] That vessel accompanies the first part of the internal maxillary artery into the parotid gland, where it joins the posterior facial vein behind the neck of the mandible.

The pterygoid venous plexus is connected with the cavernous sinus by an emissary vein. It communicates with the inferior ophthalmic vein, through the inferior orbital fissure, and with the anterior facial vein by an anastomosing channel, called the *deep facial vein*, which descends across the external surface of the buccinator muscle.

Articulatio Mandibularis.—Before the external pterygoid muscle is thrown forwards, the mandibular joint must be examined. It is a diarthrodial joint of the ginglymus type, and its cavity is separated into an upper and a lower part by an articular disc. In connection with it there are the following ligaments:—

[1] The internal maxillary vein may be replaced by two venæ comites.

Ligaments Proper.	Accessory Ligaments.
1. Capsula articularis. Lig. temporo-mandibulare.	2. Lig. spheno-mandibulare. 3. Lig. stylo-mandibulare.
Discus Articularis.	

The *articular capsule* encloses the joint cavity. Above, it is attached posteriorly, laterally and medially to the margin of the mandibular fossa, and, anteriorly, to the anterior margin of the articular tubercle. Below, it is attached to the neck of

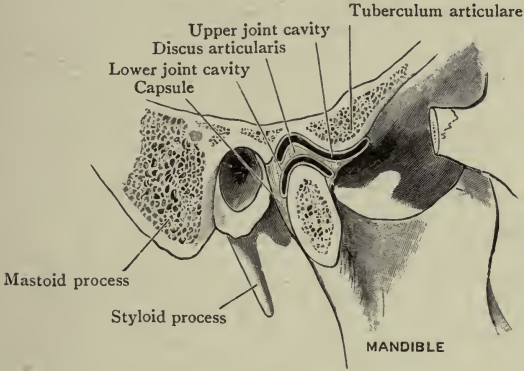


Fig. 64.—Section through the Mandibular Joint.

the mandible; and between its upper and lower attachments it is connected with the margins of the articular disc.

The *temporo-mandibular ligament* is a strong triangular band of the capsule attached, by its base, to the lateral surface of the posterior part of the zygoma and to the tubercle at the root of the zygoma. Its fibres run downwards and backwards to the lateral margin of the neck of the mandible.

The *spheno-mandibular ligament* (O.T. *internal lateral*) is a long membranous band which extends from the spine of the sphenoid to the lingula of the mandible and to the sharp medial margin of the mandibular foramen. It is not in direct relationship with the joint. Above, it lies medial to the external pterygoid muscle and the auriculo-temporal nerve; lower down, the internal maxillary vessels intervene between it and the neck of the mandible; whilst, still lower, the inferior alveolar vessels and nerve are interposed between it and the ramus of the mandible.

The *stylo-mandibular ligament* is a fibrous band, derived from that portion of the deep cervical fascia which forms a part of the capsule of the parotid gland. It is attached, above, to the styloid process, and, below, to the angle and posterior border of the ramus of the mandible, between the internal pterygoid and masseter muscles.

An examination of the spheno-mandibular and stylo-mandibular ligaments will show that very little is added to the strength of the joint by their presence. The security of the joint depends not so much upon its ligaments as upon the strong muscles of mastication, which keep the head of the mandible in its place.

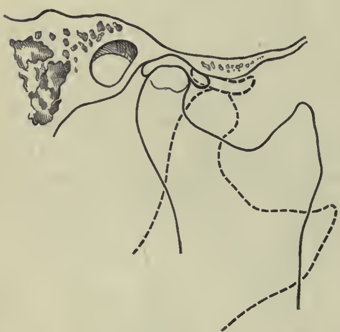


FIG. 65.—Diagram of the different positions occupied by the head of the mandible and the discus articularis as the mouth is opened and closed.

The *articular disc* is an oval plate of fibro-cartilage, with its long axis directed transversely. It is interposed between the condyle of the mandible below and the mandibular fossa (O.T. glenoid) and the articular tubercle (O.T. eminentia articularis) above, and it divides the joint cavity into an upper and a lower part, each of which is provided with a separate synovial lining. To expose the disc, the temporo-mandibular ligament must be removed. The disc will then be seen to be adapted to the two bony surfaces between which it lies. Above, it is concavo-convex in correspondence with the tuberculum articulare and the mandibular fossa of the temporal bone; whilst below, it is concave, and fits upon the upper aspect of the condyle of the mandible. In the centre it is thin, and in some cases it is perforated. Its circumference is thick, more especially posteriorly. It should be noted also that the external pterygoid muscle is partly inserted into the capsule at its anterior border.

The *synovial stratum* which lines the capsule enclosing the upper cavity of the joint is of greater extent and looser than that of the lower compartment. The greater extent of the synovial stratum of the upper cavity of the joint is associated with the larger size of the articular surface of the temporal bone as contrasted with the condylar surface.

Movements. — The movements which the mandible can perform at the mandibular joint are the following:—(1) depression; (2) elevation; (3) protraction; (4) retraction; (5) side to side or chewing movements. When the mandible is depressed the articular disc and the condyle move forwards in the mandibular fossa, and the condyle finally takes up a position on the tuberculum articulare. The forward gliding of the disc and condyle in the upper compartment of the joint is accompanied by another movement in the lower compartment of the joint, which consists in a rotation of the condyle of the mandible on the lower surface of the articular disc. Elevation of the mandible or closure of the mouth is brought about by a reverse series of changes in both compartments of the joint. There is some doubt about the position of the transverse axis around which the movements of elevation and depression take place, but it is generally supposed to be situated at the level of the mandibular foramina. Those are the points, therefore, of least movement, and consequently in opening and shutting the mouth the inferior alveolar vessels and nerves are not unduly stretched. In protraction and retraction the movement is confined chiefly to the upper compartment of the joint, and the condyle of the mandible, with the articular disc, glides forwards and backwards upon the temporal articular surface. In the side to side movements of the jaw the mandible is carried alternately from one to the other side, as in the process of chewing.

The muscles on each side which are chiefly engaged in producing these movements are the following:—(1) *depressors*—the platysma, the mylohyoid, and the anterior belly of the digastric; (2) *elevators*—the masseter, internal pterygoid, temporal; (3) *protractors*—the external pterygoid, and to some extent the internal pterygoid and the superficial fibres of the masseter; (4) *retractor*—the posterior fibres of the temporal and the deep fibres of masseter; (5) *side to side movement* is produced by the muscles of opposite sides acting alternately.

Dissection.—The condyle of the mandible must now be disarticulated and thrown forwards with the attached external pterygoid muscle. It is well to detach the articular disc with the head of the bone, in order that it may be more thoroughly examined. Care must be taken not to injure the auriculotemporal nerve, which lies in close proximity to the medial aspect of the joint. When the disarticulation is complete, draw the muscle forwards by gently pushing the condyle under the internal maxillary artery.

When the external pterygoid has been reflected and the areolar tissue medial to it has been cleaned away the following structures will be exposed. The *middle meningeal artery*; the *mandibular division of the trigeminal nerve* and its branches; the *chorda tympani* branch of the facial nerve, and, in a well-injected subject, the *tympanic* and *accessory meningeal branches of the internal maxillary artery* may be seen. Follow the middle meningeal artery upwards. Just before it enters the foramen spinosum it passes between the two heads of origin by which the auriculo-temporal nerve springs from the back of the posterior division of the mandibular nerve. Follow the auriculo-temporal nerve backwards and note how close it lies to the medial face of the capsule of the temporo-mandibular joint, before it enters the parotid region and ascends behind the condyle of the mandible to the temporal region. Next clean the upper part of the inferior alveolar nerve. Then turn to the lingual nerve; first clean its surface, then pull it forwards and secure the chorda tympani which joins its posterior border, after passing medial to the inferior alveolar nerve. Note that the mandibular nerve divides into anterior and posterior parts. The posterior division gives off the two roots of the auriculo-temporal nerve and then divides into the inferior alveolar and lingual branches, whilst the anterior division supplies all the muscles of mastication, except the internal pterygoid and sends the sensory buccinator nerve to the mucous membrane and skin over the buccinator muscle. Now secure the *nerve to the internal pterygoid muscle* which springs from the anterior part of the trunk of the mandibular nerve, and, if possible, the small *nervus spinosus* which passes backwards and laterally to the foramen spinosum.

Arteriæ Meningea Media et Tympanica et Ramus Meningeus Accessorius.—The *middle meningeal artery* has already been seen arising from the first part of the internal maxillary artery. It passes upwards, medial to the external pterygoid muscle and lateral to the tensor veli palatini, and disappears from view through the foramen spinosum, by which it enters the cranial cavity (p. 118). It is usually embraced by the two roots of the auriculo-temporal nerve.

The *accessory meningeal artery* and the *tympanic artery* generally arise from the middle meningeal. The *accessory meningeal* inclines forwards and upwards, and enters the cranial cavity by passing through the foramen ovale; the *tympanic* runs upwards and backwards, and reaches the tympanum by passing through the petro-tympanic fissure (O.T. Glaserian). In the tympanic cavity it anastomoses with the stylo-mastoid branch of the posterior auricular artery.

Nervus Mandibularis.—The mandibular branch of the trigeminal nerve arises, within the cranium, from the semilunar (O.T. Gasserian) ganglion, and enters the infratemporal region through the foramen ovale. It is composed of *sensory fibres*, but it is accompanied through the foramen by the small *motor root* of the trigeminal nerve; and by the union of the sensory and motor parts, immediately after they gain the exterior of the cranium, a *mixed nerve-trunk* results, which lies medial to the external pterygoid muscle and lateral to the tensor veli palatini.

Immediately after its exit from the skull the mandibular nerve gives off the nervus spinosus and the nerve to the internal pterygoid muscle, and, at a slightly lower level, it divides into an anterior division, and a posterior division which almost immediately breaks up into its lingual, alveolar and auriculo-temporal divisions.

The *nervus spinosus* is a very slender twig which enters the cranium by accompanying the middle meningeal artery

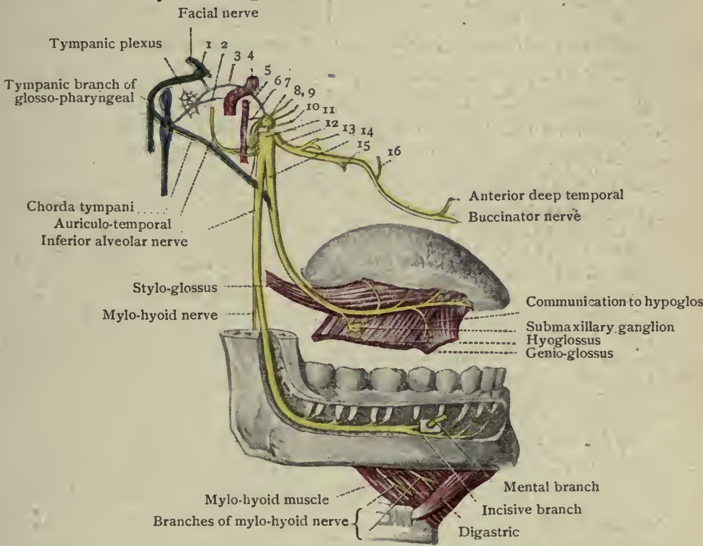


FIG. 66.—Diagram of Mandibular Nerve. (By Prof. A. M. Paterson.) The tongue has been separated from its attachments and raised above the level of the body of the mandible.

1. Ganglion geniculi
2. Carotico-tympanic nerve
3. Lesser superficial petrosal nerve
4. Internal carotid artery
5. Middle meningeal artery
6. Symp. root of otic ganglion
7. Otic ganglion
8. Nerve to tensor tympani
9. Nerve to tensor veli palatini
10. Nerve to internal pterygoid
11. Mandibular nerve trunk
12. Anterior division
13. Deep temporal
14. Lingual nerve
15. Masseteric branch
16. Pterygoid branch

through the foramen spinosum. It supplies the dura mater, and sends a twig into the tympanum.

The *nerve to the internal pterygoid* will be found, passing forwards, under cover of the posterior border of the upper end of the internal pterygoid muscle. In close relation to its commencement is the *otic ganglion.*

The anterior division arises from the trunk of the mandibular nerve about 5 mm. below the foramen ovale. It consists almost entirely of motor fibres derived from the motor root of the mandibular nerve; but it contains also a few sensory fibres which are afterwards distributed by its buccinator branch.

It passes downwards and forwards on the medial side of the external pterygoid muscle, and it gives off the following branches:—

1. Masseteric.
2. Two deep temporal.
3. External pterygoid.
4. Buccinator.

Nervus Massetericus.—The masseteric nerve runs horizontally above the external pterygoid muscle, and, after passing through the incisura mandibulæ (O.T. sigmoid notch), posterior to the temporal muscle, it enters the posterior and upper part of the deep surface of the masseter. Before reaching the masseter it gives one or two twigs to the mandibular joint.

Nervi Temporales Profundi. — There are usually two deep temporal nerves, *anterior* and *posterior.* The posterior nerve is the smaller of the two; it frequently arises by a common root with the masseteric. Both deep temporal nerves pass laterally above the external pterygoid, and then turn upwards on the medial wall of the temporal fossa. They supply the temporal muscle.

Nervus Buccinatorius.—The buccinator nerve (O.T. long buccal) is the largest of the branches arising from the anterior division. It proceeds laterally between the two heads of the external pterygoid muscle, and then runs downwards and forwards under cover of the temporal muscle, and under cover of the anterior border of the masseter also, to reach the outer surface of the buccinator muscle. There it unites with branches of the facial nerve to form the *buccal plexus*, from which branches are distributed to the mucous membrane and skin of the cheek.

The buccinator nerve is a sensory nerve, and all the sensory fibres in the anterior division enter into its composition. A few motor fibres, however, are also prolonged into it; they leave it in two branches, viz., (1) in the *nerve to the external pterygoid*, which, as a rule, arises in common with the buccinator nerve; and (2) in the anterior deep temporal nerve to the temporal muscle. The anterior deep temporal nerve springs from the buccinator nerve, either before or after it has reached the lateral surface of the external pterygoid, and proceeds upwards to supply the anterior part of the temporal muscle (Fig. 63). In some cases the buccinator nerve pierces the temporal muscle instead of passing under cover of it.

The posterior division of the mandibular nerve consists mainly of sensory fibres, but it still contains a few motor fibres which ultimately pass into its alveolar branch and thence to the mylo-hyoid nerve.

Nervus Auriculo-Temporalis.—The auriculo-temporal nerve springs by two roots from the posterior division of the mandibular nerve, under cover of the external pterygoid. The two roots are composed of sensory fibres and each receives a communication from the otic ganglion, by means of which it is brought, indirectly, into association with the glosso-pharyngeal nerve. The roots embrace the middle meningeal artery, and unite posterior to it to form a stem which runs backwards between the neck of the mandible and the spheno-mandibular ligament. At the interval between the ear and mandible it turns upwards, in relation to the antero-medial surface of the parotid gland, crosses the zygoma in company with the superficial temporal artery, and enters the scalp, where it breaks up into terminal branches (Fig. 51).

Its branches are: (1) one or two strong branches of communication to the upper division of the facial nerve; (2) a few slender filaments which enter the posterior aspect of the mandibular joint; (3) some twigs to the parotid gland; (4) terminal filaments to the skin over the temporal region and summit of the head; (5) auricular branches.

The *auricular* branches are usually *two* to the skin lining the upper part of the interior of the external meatus, and *two* to the integument over the upper and anterior part of the auricle. The former gain the interior of the meatus by passing between the osseous and cartilaginous portions of the canal.

Nervus Alveolaris Inferior.—The inferior alveolar nerve (O.T. inferior dental) is the largest branch of the posterior division of the mandibular nerve. It emerges from under cover of the external pterygoid, at the lower border of the muscle, passes downwards along the lateral surface of the spheno-mandibular ligament, and enters the mandibular foramen. The inferior alveolar artery runs downwards posterior to it, whilst the lingual nerve is anterior to it and upon a somewhat deeper plane. The inferior alveolar is a sensory nerve, but a few fibres from the motor root are prolonged downwards within its sheath as far as the mandibular foramen.

At that point they separate off as the slender mylo-hyoid nerve (Figs. 63, 68).

The *mylo-hyoid nerve*, accompanied by the artery of the same name, pierces the spheno-mandibular ligament and proceeds downwards and forwards, in a groove upon the medial surface of the mandible, to the digastric triangle. A narrow prolongation of the spheno-mandibular ligament bridges over the groove and holds the nerve and vessel in position. In the digastric triangle the mylo-hyoid nerve has been dissected already (p. 129). It breaks up into numerous branches for the supply of two muscles, viz., (1) the mylo-hyoid, and (2) the anterior belly of the digastric (Fig. 68).

Nervus Lingualis.—The lingual nerve is entirely sensory. In the first part of its course, like the other branches of the mandibular nerve, it lies medial to the external pterygoid muscle. As it descends it appears at the lower border of the muscle. Then it proceeds downwards and anteriorly, between the internal pterygoid muscle and the mandible, and enters the submaxillary region, where it will afterwards be traced to the tongue. It lies anterior to and on a slightly deeper plane than the inferior alveolar nerve. It gives off no branches in the infratemporal region, but, whilst still under cover of the external pterygoid, it is joined at an acute angle by the *chorda tympani branch* of the facial nerve. Not infrequently, also, a communicating twig passes between it and the inferior alveolar nerve.

Chorda Tympani.—The chorda tympani is a slender nerve which arises from the facial in the canalis nervi facialis (O.T. aqueduct of Fallopius). It gains the infratemporal region by traversing the tympanic cavity and appearing through the medial part of the petro-tympanic fissure (O.T. Glaserian), whence it runs downwards and forwards, medial to the spheno-mandibular ligament. It is joined by a slender filament from the otic ganglion, and it unites with the lingual nerve a short distance below the upper end of the latter.

Dissection.—The student should now endeavour, by means of a Hey's saw, a chisel, and the bone forceps, to remove the outer table of the mandible, and thus open up the mandibular canal.

Structures within the Mandibular Canal.—The mandibular canal is traversed by the *inferior alveolar vessels and nerve*, which give off twigs to the roots of the molar and præmolar teeth. Both the artery and the nerve terminate by dividing into a mental and an incisor branch.

The *mental artery and nerve* appear on the face through the mental foramen, and have been examined already; the *incisor artery and nerve* pass forwards to the symphysis and send up twigs to the canine and incisor teeth. The vessel anastomoses, in the bone, with the corresponding artery of the opposite side.

SUBMAXILLARY REGION.

The superficial area of the submaxillary region has been dissected already, under the name of the submental triangle of the digastric triangle (p. 127). It is now necessary to carry the dissection to a deeper plane, in order to expose a number of parts in connection with the tongue and floor of the mouth. The structures to be displayed are :—

1. Submaxillary gland and its duct.
2. Sublingual gland.
3. Side of the tongue, and the mucous membrane of the mouth.
4. Muscles.
   - Mylo-hyoid.
   - Digastric.
   - Stylo-hyoid.
   - Hyoglossus.
   - Stylo-glossus.
   - Genio-hyoid.
   - Genio-glossus.
5. Nerves.
   - Mylo-hyoid.
   - Hypoglossal.
   - Lingual.
   - Glosso-pharyngeal.
6. Submaxillary ganglion.
7. Lingual artery and veins.
8. Part of the external maxillary artery.
9. Stylo-hyoid ligament.

Dissection.—To prepare the part for dissection, it is necessary to throw back the head to its full extent, and turn it slightly to the opposite side. If the stuffing in the mouth has not been previously removed, it should be taken out now. When that has been done, divide the external maxillary artery and the anterior facial vein at the point where they cross the lower border of the mandible. Next, detach the anterior belly of the digastric from its attachment to the anterior part of the medial aspect of the lower border of the mandible; and then, with the saw, cut through the mandible lateral to the median plane.[1]

[1] If the part is soft and pliable there may be no necessity to make this division of the bone.

It is essential that the division of the anterior part of the mandible should be slightly lateral to the median plane on each side, in order that the median part of the bone, with the attachments of the genioid muscles, may be left intact.

After the division of the bone has been completed the lower border of the lateral part of the mandible must be everted,

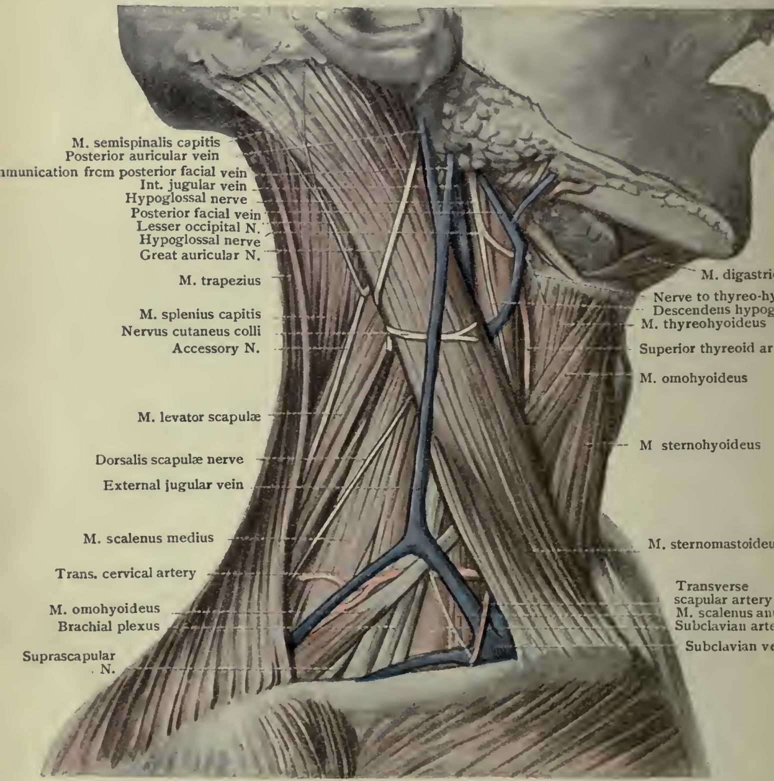


FIG. 67.—The Triangles of the Neck seen from the side. The clavicular head of the sterno-mastoid muscle was small, and therefore a considerable part of the scalenus anterior muscle is seen.

turned slightly upwards, and fixed in position with hooks. When that has been done the boundaries and contents of the submaxillary region can be examined.

Part of the region has already been seen as the digastric portion of the anterior triangle of the neck, but it will now be obvious that the region occupied by the submaxillary gland is much more extensive than the digastric triangle; for, although both are bounded anteriorly and posteriorly by the anterior and posterior bellies of the digastric muscle, the upper boundary of the digastric triangle is the lower border of the mandible, whilst the submaxillary region extends upwards to the level of the mylo-hyoid ridge on the inner surface of the mandible.

After the mandible has been turned upwards the dissector should proceed, in the first place, to examine the relations of the digastric and stylo-hyoid muscles, then the mylo-hyoid muscle, and afterwards he must study the submaxillary and sublingual glands and the deeper structures which are found in the medial boundary of the submaxillary region.

Musculus Digastricus.—The digastric muscle limits the submaxillary region inferiorly, and separates it from the carotid and submental triangles (Figs. 67, 68).

The *anterior belly* of the digastric springs from the inner part of the lower border of the mandible, close to the symphysis; the *posterior belly* arises from the mastoid notch of the temporal bone, on the medial side of the mastoid process. The two bellies converge upon the upper border of the hyoid bone, where they are united by an intermediate tendon, which is attached to the hyoid bone, at the junction of the body with the greater cornu, by a strong loop of fibrous tissue developed from the deep cervical fascia. Posterior to the loop, through which it plays, the intermediate tendon passes through the cleft lower end of the stylo-hyoid muscle.

Relations.—The anterior belly is covered by the skin, superficial fascia and the platysma, and the deep fascia. It is overlapped by the anterior border of the submaxillary gland, and its deep surface is in contact with the mylo-hyoid muscle. Its anterior border is the posterior boundary of the submental triangle, and its posterior border is the anterior boundary of the digastric triangle.

The relations of the posterior belly are more numerous and important. Posteriorly, it is covered by the mastoid process and the attachments of the sterno-mastoid and splenius capitis muscles. Between the mastoid process and the angle of the mandible it forms part of the postero-medial boundary of the parotid space and is covered by the parotid gland; next, it is covered by the angle of the mandible and the insertion of the internal pterygoid muscle. As it lies in the anterior triangle it is covered by the skin, the superficial fascia and platysma, and the deep fascia; it is crossed by the anterior facial vein, and is overlapped by the posterior part of the submaxillary gland.

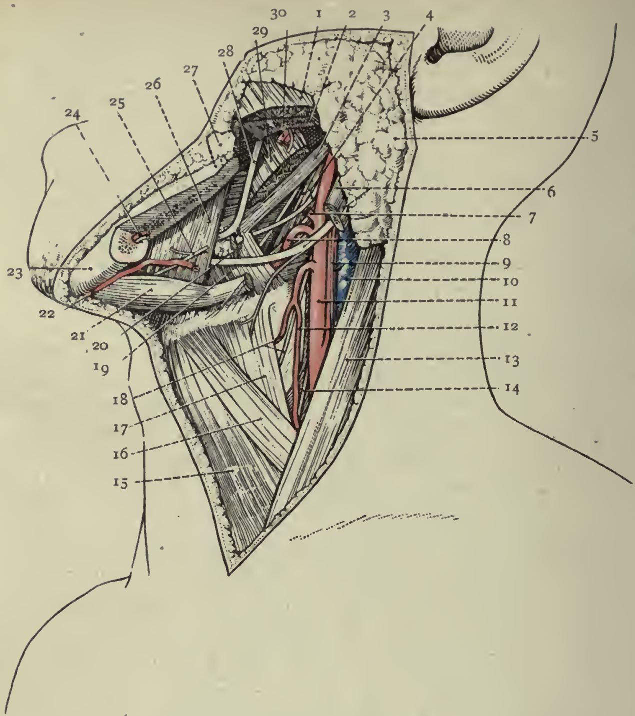


FIG. 68.—Deep dissection of the Infratemporal and Submaxillary Regions.

1. Masseter muscle.
2. Mandible.
3. Stylo-glossus muscle.
4. Stylo-pharyngeus muscle and glosso-pharyngeal nerve.
5. Parotid gland.
6. Stylo-hyoid and digastric muscles
7. External maxillary artery.
8. Lingual artery.
9. Internal carotid artery and descending branch of hypoglossal nerve.
10. Internal jugular vein.
11. External carotid artery.
12. Superior thyreoid artery.
13. Sterno-mastoid muscle.
14. External laryngeal nerve.
15. Sterno-hyoid muscle.
16. Omo-hyoid muscle.
17. Thyreo-hyoid muscle.
18. Laryngeal branch of superior thyreoid artery and internal laryngeal nerve.
19. Hyoglossus muscle.
20. Deep part of submaxillary gland and duct of gland.
21. Anterior belly of digastric muscle.
22. Submental branch of external maxillary artery.
23. Mandible.
24. Inferior alveolar artery and nerve.
25. Mylo-hyoid nerve.
26. Mylo-hyoid muscle.
27. Position of last molar tooth of mandible.
28. Lingual nerve.
29. Internal pterygoid muscle.
30. Inferior alveolar nerve, and mylo-hyoid branch with inferior alveolar artery.

It is superficial to the internal jugular vein, the internal and the external carotid arteries, the external maxillary artery, the middle constrictor of the pharynx, and the lower and posterior part of the hyoglossus muscle. The accessory nerve passes backwards and downwards between it and the internal jugular vein, and the occipital artery passes upwards and backwards under cover of its lower border, superficial to the accessory nerve. The hypoglossal nerve descends vertically on its deep surface in the angle between the internal jugular vein and the internal carotid artery, and the glosso-pharyngeal nerve passes forwards and downwards between it and the internal carotid. The posterior auricular artery runs upwards and backwards along the posterior part of its upper border under cover of the postero-medial surface of the parotid, and the stylo-hyoid muscle descends along the same border (Fig. 68).

The posterior belly is supplied by the *facial nerve*, and the anterior belly is supplied by the *mylo-hyoid branch* of the inferior alveolar nerve.

If the digastric acts from its posterior attachment it depresses the mandible. If the mandible is fixed and the diagastric acts from its anterior attachment it helps to pull the head backwards. If both the bellies act simultaneously the hyoid bone is raised.

Musculus Stylohyoideus.—The stylo-hyoid muscle is a small muscular bundle which springs from the posterior border and lateral surface of the middle third of the styloid process and descends along the upper border of the posterior belly of the digastric. It divides below into two slips which embrace the intermediate tendon of the digastric and are then inserted into the hyoid bone, at the junction of the greater cornu with the body. Its main relations are practically the same as those of the posterior belly of the digastric, but it is not under cover of the mastoid process, the sterno-mastoid, and the splenius muscles. It is supplied by the *facial nerve*. It raises the hyoid bone and draws it backwards.

Dissection.—Turn the anterior part of the submaxillary gland backwards, and clean the posterior part of the mylo-hyoid muscle, which lies deep to it. Note that a process, the *deep part* of the gland, springs from the medial surface of the superficial part and passes forwards, deep to the mylo-hyoid. Dissect the external maxillary artery out of the deep sulcus in the posterior part of the gland, without injuring its submental branch, which runs forwards, along the lower border of the mandible; then displace the posterior part of the gland forwards and expose the hypoglossal nerve immediately above the greater cornu of the hyoid bone, and, at a higher level, the lingual nerve. Both nerves lie on the lateral surface of the hyoglossus muscle. Hanging from the lower border of the lingual nerve is the small submaxillary ganglion, from which several branches pass to the gland. Note again the deep part of the gland, springing from the medial surface of the superficial part, and also the duct of the gland emerging from the superficial part of the gland and passing forwards, with the deep part, between the mylo-hyoid muscle laterally and the hyoglossus medially. Then study the position and relations of the superficial portion of the gland. The relations of the deep part will be seen after the mylo-hyoid is reflected.

Glandula Submaxillaris.—The submaxillary salivary gland consists of a superficial larger portion and a deep smaller portion. The superficial portion is lodged in a space which is bounded anteriorly by the anterior belly of the digastric; posteriorly by the posterior belly of the digastric, the stylo-hyoid, and the stylo-mandibular ligament; below by the deep fascia of the neck; laterally by the medial surface of the body of the mandible and the lower part of the medial surface of the internal pterygoid muscle; and medially by the mylo-hyoid and hyoglossus muscles. The fascial relations of the gland have been described already (p. 123). The dissector should note now that, in accordance with the contour of the space in which it lies, he can recognise that the superficial part of the gland possesses an anterior and a posterior extremity, and three more or less well-defined surfaces, inferior, lateral, and medial. The *posterior extremity* abuts against the stylo-mandibular ligament, which separates it from the parotid, and it overlaps the stylo-hyoid and posterior belly of the digastric. It is cleft by a groove in which lies the external maxillary artery. The *anterior extremity* rests on the anterior belly of the digastric muscle.

The *inferior surface* is covered by the layer of deep cervical fascia which extends upwards from the greater cornu of the hyoid bone to the lower border of the mandible; it is crossed posteriorly, under cover of the deep fascia, by the anterior facial vein. Along its upper border lie the majority of the submaxillary lymph glands; the external maxillary artery turns round between it and the lower border of the mandible, at the anterior border of the masseter; and the submental branch of the external maxillary artery runs forwards in the angle between it and the mandible.

The *lateral surface* is in relation, posteriorly, with the lower part of the medial surface of the internal pterygoid, and anteriorly with the medial surface of the body of the mandible, below the mylo-hyoid ridge. The external maxillary artery, as it lies in the groove in the posterior end of the gland, and before it turns round the lower border of the mandible, runs forwards and downwards between this surface

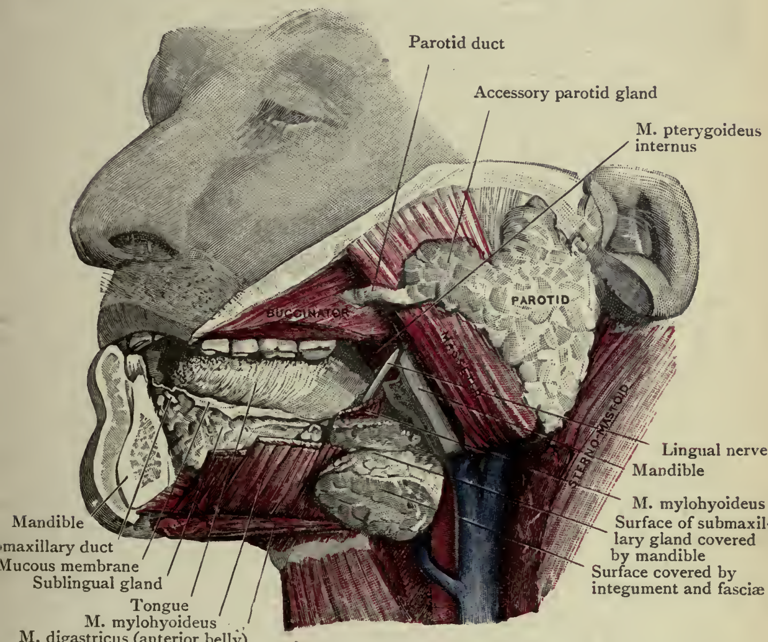


FIG. 69.—Dissection of the Parotid, Submaxillary, and Sublingual Glands.

and the internal pterygoid; and the mylo-hyoid artery and nerve lie between it and the body of the mandible before they pass, more anteriorly, to the medial surface of the gland. The *medial surface* is in relation with the mylo-hyoid and hyoglossus, the lingual nerve and the submaxillary ganglion, and the hypoglossal nerve. It overlaps the stylo-hyoid muscle, both bellies of the digastric, and, sometimes, the greater cornu of the hyoid bone. The deep part of the gland and the duct both spring from the medial surface before they pass forwards between the mylo-hyoid and the hyoglossus muscles (Fig. 71).

The nerve supply of the gland is derived from the lingual nerve, the submaxillary ganglion, and the sympathetic plexus on the external maxillary artery; its vascular supply consists of small glandular branches from the external maxillary artery.

The relations of the deep part of the gland and the duct will be investigated after the mylo-hyoid has been reflected.

> ***Dissection.***—**Displace the superficial part of the gland and the submental branch of the external maxillary artery backwards; cut the mylo-hyoid vessels and nerve, and turn the anterior belly of the digastric downwards; then clean the mylo-hyoid muscle and examine its attachments.**

Musculus Mylohyoideus.—The mylo-hyoid muscle is a thin sheet of muscular fibres, which arises from the mylo-hyoid line upon the medial surface of the body of the mandible, by an origin which extends from the last molar tooth to the symphysis. Its fibres are directed downwards, medially and forwards, and present two different modes of insertion. The posterior fibres are inserted into the body of the hyoid bone; they, however, form a comparatively small part of the muscle. Most of the fibres are inserted into a median raphe which extends between the symphysis of the mandible and the body of the hyoid bone. The two mylo-hyoid muscles, therefore, stretch across from one side of the body of the mandible to the other, in front of the hyoid bone, and constitute a floor for the anterior part of the mouth which is frequently termed the *diaphragma oris*. The mylo-hyoid muscle is supplied by the *mylo-hyoid branch* of the *inferior alveolar nerve*. It elevates the hyoid bone, the tongue and the floor of the mouth in the movement of swallowing.

> ***Dissection.***—**Cut the mylo-hyoid muscle a little below its origin from the mylo-hyoid ridge and turn it downwards and forwards. Be careful not to injure the mucous membrane of the mouth, which lies in contact with the upper surface of the muscle near its origin.**

Parts exposed by the Reflection of the Mylo-hyoid (Fig. 70).—Part of the tongue, and a number of structures associated with it are now brought into view. First, note the mucous membrane stretching from the tongue to the inner side of the mandible; then, identify the various muscles. The *hyoglossus*, a portion of which was previously visible behind the mylo-hyoid, is fully exposed. It is a quadrangular sheet of fleshy fibres which extends from the hyoid bone to the side of the tongue. Mark its position, because all the structures in the region now under consideration have a more or less intimate relationship to it. Thus, posterior and also superficial to its upper part, the *stylo-glossus muscle* will be recognised, whilst anterior to it are the *genio-glossus* and the

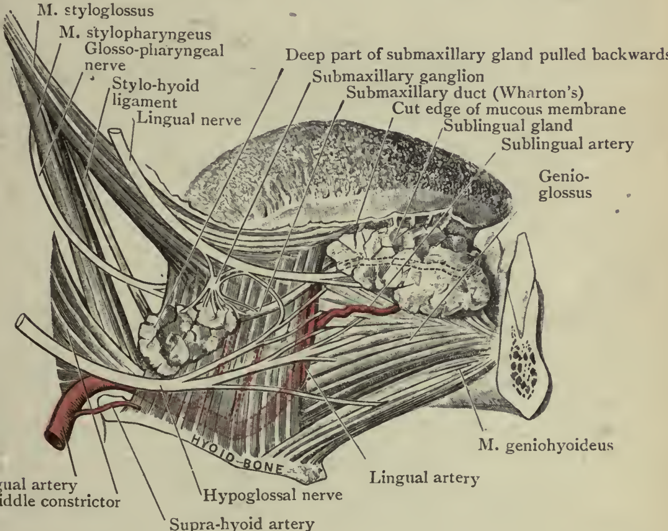


FIG. 70.—Dissection of Submaxillary Region.

genio-hyoid. The genio-hyoid muscle occupies the antero-inferior part of the region, whilst the anterior part of the genio-glossus is seen in the interval between the genio-hyoid and the hyoglossus. Upon the surface of the hyoglossus, the lingual and hypoglossal nerves, the connecting loop between them, the deep portion of the submaxillary gland, with the submaxillary duct, and the submaxillary ganglion, are to be dissected. The *lingual nerve* occupies the highest level, and passes forwards upon the muscle, near its insertion into the tongue. The *hypoglossal nerve*, with its *vena comitans* and the lingual vein, crosses the muscle close to the hyoid bone, whilst the *deep part of the submaxillary gland* and the *submaxillary duct* (Wharton's) occupy an intermediate place. Although the *submaxillary ganglion* is very small, its relations are so precise that it is very easily found. By seizing the lingual nerve and dissecting carefully in the interval between it and the deep part of the submaxillary gland, the dissector will expose the ganglion, and its roots and branches of distribution (Fig. 70). Upon the genio-glossus, anterior to the

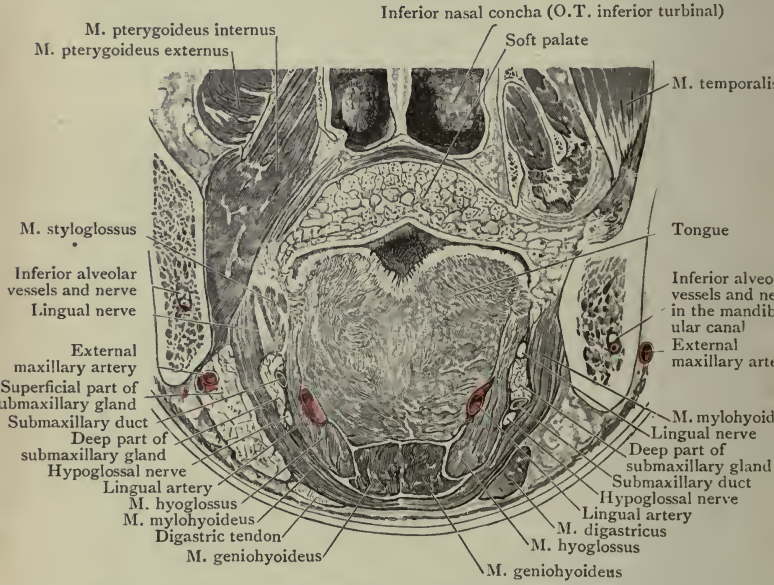


FIG. 71.—Frontal section through the Tongue and Submaxillary Region in a plane posterior to the molar teeth.

hyoglossus, the *sublingual gland*, with its artery of supply will be seen. If the stylo-hyoid and the posterior belly of the digastric are displaced backwards, certain structures will be seen passing under cover of the posterior margin of the hyoglossus muscle. They are:—(1) the glosso-pharyngeal nerve, immediately below the stylo-glossus muscle; (2) the stylo-hyoid ligament, a little lower down; and (3) the lingual artery, close to the hyoid bone (Fig. 68).

Musculus Hyoglossus.—The hyoglossus is a quadrate, flat muscle which arises from the whole length of the greater cornu, and also from the body of the hyoid bone. Its fibres pass upwards to the posterior part of the side of the tongue, medial to the stylo-glossus. The hyoglossus is supplied by the *hypoglossal nerve*. It helps to depress the tongue and to pull its anterior part backwards.

Musculus Stylo-glossus.—The stylo-glossus muscle is an elongated fleshy slip which takes origin from the anterior aspect of the styloid process, near its tip, and, to a slight extent, from the upper part of the stylo-hyoid ligament also. It passes down-

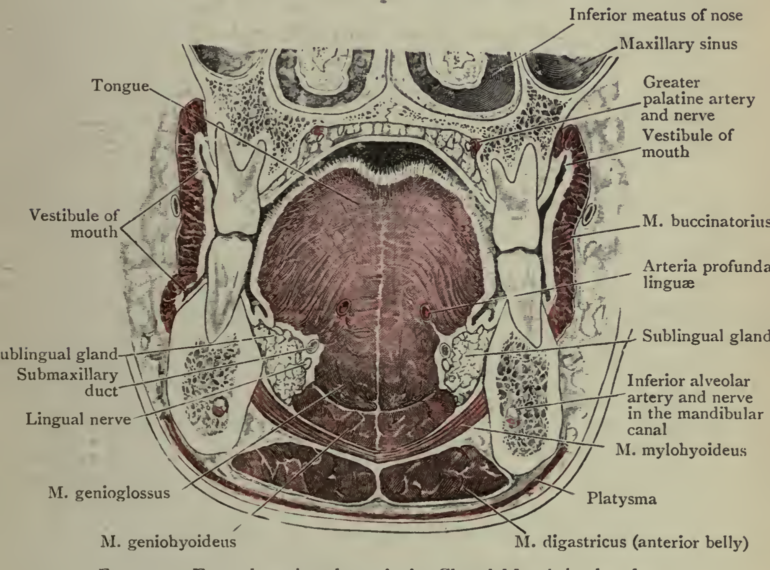


FIG. 72.—Frontal section through the Closed Mouth in the plane of the second molar teeth.

wards and forwards, and its fibres may be traced upon the side of the tongue as far as the tip. Some of them decussate with the fasciculi of the hyoglossus muscle. It pulls the tongue backwards, and its nerve of supply is derived from the *hypoglossal nerve*.

Musculus Geniohyoideus. — The genio-hyoid muscle is placed close to the median plane, in contact with its fellow of the opposite side. It is a short muscle which arises from the lower mental spine upon the posterior surface of the symphysis of the mandible, and extends downwards and backwards to gain insertion into the anterior aspect of the body of the hyoid bone. It is supplied by the *hypoglossal nerve.* It pulls the hyoid bone upwards and forwards.

The Deep Part of the Submaxillary Gland.—It has been noted already that the small, deep part of the submaxillary gland springs from the medial surface of the superficial part, at the posterior border of the mylo-hyoid muscle. It will now be obvious that it passes forwards and upwards, between the mylo-hyoid laterally and the hyo-glossus and genio-glossus medially, until it comes into contact with the sublingual gland. It is accompanied by the lingual nerve and the submaxillary duct, both of which lie on its medial surface. (Fig. 72).

Ductus Submaxillaris.—The duct of the submaxillary gland (O.T. Wharton's duct) emerges from the medial surface of the main part of the gland, and proceeds, with the deep part of the gland, forwards and upwards upon the hyo-glossus muscle. At first it lies between the lingual nerve above and the hypoglossal nerve below. Reaching the surface of the genio-glossus muscle, it is crossed laterally, and then below and medially, by the lingual nerve. Then it passes to the medial side of the sublingual gland, and gains the floor of the mouth, where it opens by a small orifice placed on the summit of a papilla which lies close to the side of the frenulum linguæ.

The wall of the duct is much thinner than that of the parotid duct. If a small opening is made in it, the dissector will experience little difficulty in passing a fine probe or bristle along it into the mouth.

Glandula Sublingualis.—The sublingual gland lies in the floor of the mouth, and is the smallest of the larger salivary glands. It is almond-shaped, about one inch and a half long; and its relations are very definite. Its prominent *upper border* can be seen within the mouth, beneath the anterior part of the tongue, where it is covered by a fold of mucous membrane termed the plica sublingualis (Fig. 105). *Medially*, it rests upon the genio-glossus muscle, whilst, *laterally*, it lies against the medial aspect of the body of the mandible, immediately lateral to the symphysis and above the mylo-hyoid line. *Below*, it is supported by the mylo-hyoid muscle. Its anterior extremity reaches the median plane, above the anterior border of the genio-glossus, and is in contact with its fellow of the opposite side. The duct of the submaxillary gland and the lingual nerve are prolonged forwards, medial to the sublingual gland.

Numerous small ducts (the number varying from eight to twenty) proceed from the sublingual gland. As a rule, they open into the mouth on the summit of the plica sublingualis (Birmingham).

Nervus Lingualis.—In the dissection of the infratemporal region, the lingual nerve was seen passing downwards between the ramus of the mandible and the internal pterygoid muscle. As it descends, it inclines forwards, and, after passing over the attachment of the superior constrictor muscle of the pharynx to the posterior end of the mylo-hyoid line, it lies below and posterior to the last molar tooth (Fig. 68), between the mucous membrane of the mouth and the body of the mandible. At that point it is in danger of being hurt by the clumsy extraction of one of the lower molars, and there also it may be divided by the surgeon, from the inside of the mouth. In its further course the nerve keeps close to the side of the tongue, crossing the styloglossus and the upper part of the hyoglossus, and, beyond that, the submaxillary duct. Its terminal branches are placed immediately under cover of the mucous membrane of the mouth, and it can be traced as far as the tip of the tongue.

The *branches* which proceed from the lingual nerve in the submaxillary region are of two kinds—(1) twigs of communication; (2) branches of distribution.

Twigs of Communication.	1. Two or more to the submaxillary ganglion. 2. One or two which descend along the anterior border of the hyoglossus muscle to unite with the hypoglossal nerve.
Branches of Distribution.	1. Slender filaments to the mucous membrane of the mouth and gums. 2. A few twigs to the sublingual gland. 3. Branches to the tongue.

The *lingual branches* pierce the substance of the tongue, and then incline upwards to supply the papillated mucous membrane over the anterior two-thirds of the organ.

Ganglion Submaxillare.—The small submaxillary ganglion lies upon the upper part of the hyoglossus muscle, in the interval between the lingual nerve and the deep part of the submaxillary gland. In size, it is not larger than the head of a large pin; and, when freed from the connective tissue surrounding, it will be seen to be suspended from the lingual nerve by two short branches, which enter its upper border, and are separated by a distinct interval. The posterior connecting twig is frequently replaced by two or three filaments, which form the sensory and secretory roots of the ganglion, whilst the anterior connecting branch must be looked upon as a twig given by the ganglion to the lingual nerve.

Like the other ganglia developed in connection with the branches of the trigeminal nerve, the submaxillary ganglion has three roots—viz., (1) a *sensory root* from the lingual nerve; (2) a *secretory root* from the chorda tympani; and (3) a *sympathetic root* from the plexus around the external maxillary artery.

From its lower border several minute twigs proceed; they are distributed—(1) to the submaxillary gland and duct; (2) to the sublingual gland, from the branch given by the ganglion to the lingual nerve; and (3) to the mucous membrane of the mouth.

Nervus Hypoglossus.—The hypoglossal nerve has been traced, in the dissection of the anterior triangle, to the point where it disappears under cover of the mylo-hyoid muscle (p. 130). It is now seen passing forwards upon the hyoglossus muscle, above the hyoid bone and below the level of the deep part of the submaxillary gland. At the anterior border of the hyoglossus it gains the surface of the genio-glossus muscle, into the substance of which it sinks; and finally it breaks up into branches which supply the muscular substance of the tongue. Upon the hyoglossus muscle it is accompanied by the lingual vein.

The *branches* which spring from the hypoglossal nerve in the region of the floor of the mouth are very numerous, and are distributed entirely to muscles. It supplies—(1) the stylo-glossus; (2) the hyoglossus; (3) the genio-glossus; (4) the genio-hyoid; and (5) the intrinsic muscles of the tongue.

In addition, it communicates freely with the lingual nerve. The more apparent of the connections take the form of one or more loops which lie on the lateral surface of the anterior part of the hyoglossus. Other communications with the lingual nerve are effected in the substance of the tongue.

Dissection.—The hyoglossus should now be carefully detached from the hyoid bone, and thrown upwards towards the tongue, but the structures which lie upon the superficial surface of the muscle need not be divided. By the reflection of the hyoglossus muscle the following structures will be fully displayed, and must be cleaned—(1) the profunda linguæ artery and the veins which accompany it; (2) the dorsales linguæ arteries and veins; (3) the posterior part of the genio-glossus; (4) the origin of the middle constrictor of the pharynx; and (5) the attachment of the stylo-hyoid ligament.

Musculus Genioglossus.—The genio-glossus is a flat triangular muscle, the medial surface of which is in contact with its fellow of the opposite side, in the median plane. It arises by a short pointed tendon from the upper mental spine on the posterior aspect of the symphysis of the mandible, and, from that point, its fleshy fasciculi spread out in a fan-like manner. By far the greater part of the muscle is inserted into the tongue, by an insertion which extends throughout the whole length of the organ, from the tip to the base; below the tongue, a few fibres reach the side of the pharynx. The genio-glossus is supplied by twigs from the *hypoglossal nerve*. It can project the tip of the tongue forwards and depress the whole organ in the floor of the mouth.

Arteria Lingualis. — As the lingual artery is now fully exposed, it can be conveniently studied at this stage. It springs from the anterior aspect of the external carotid, and is separable into two parts—viz., (1) a part extending from its origin to the posterior border of the hyoglossus muscle; (2) a part lying in relation to the upper border of the hyoid bone, and extending to the anterior border of the hyoglossus, where it divides into two terminal branches, the sublingual and the deep artery of the tongue (Figs. 68, 70).

The *first part* has been fully examined in a previous dissection. It lies in the carotid triangle of the neck, and is therefore comparatively superficial. It is crossed, superficially, by the hypoglossal nerve, and lies, medially, against the middle constrictor. The *second part* passes forwards along the upper border of the greater cornu of the hyoid bone, and is covered by the hyoglossus muscle, which intervenes between it and the hypoglossal nerve. The nerve, however, is placed at a slightly higher level. The deep or medial relations of the artery, in the second stage of its course, are the middle constrictor of the pharynx and the genio-glossus.

The *branches* of the lingual artery are:—

1. Supra-hyoid, from the *first* part (p. 133).
2. Dorsales linguæ, from the *second* part.
3. Sublingual.
4. Profunda.

Rami Dorsales Linguæ.—The dorsales linguæ branches are generally two or more in number. They pass upwards, under cover of the hyoglossus muscle, to end in twigs to the mucous membrane covering the pharyngeal part of the dorsum of the tongue. Some twigs are supplied also to the muscular substance of the organ, and a few may be traced backwards into the palatine tonsil.

Arteria Sublingualis.—The sublingual artery springs from the end of the second part of the lingual artery and emerges from under cover of the anterior border of the hyoglossus; then it ascends, upon the genio-glossus, to the sublingual gland, which it supplies. It gives branches to the surrounding muscles; and it anastomoses with its fellow of the opposite side and, through the mylo-hyoid muscle, with the submental branch of the external maxillary artery.

Arteria Profunda Linguæ.—The deep artery of the tongue ascends almost vertically, upon the genio-glossus, overlapped by the anterior border of the hyoglossus; when it reaches the under surface of the tongue, it runs towards the tip and ends in terminal branches. To expose it divide the mucous membrane along its course; then it will be seen to lie close to the attachment of the frenum of the tongue, and to be continued forwards in the interval between the genio-glossus and the inferior longitudinal muscle. Its course is tortuous, to allow for the protrusion or elongation of the tongue; and it gives off numerous branches.

Venæ Linguales.—The lingual artery may be accompanied by two small venæ comites which lie beside it under cover of the hyoglossus; but the main vein of the tongue crosses the lateral surface of the hyoglossus below the hypoglossal nerve; and another smaller vein, the *vena comitans hypoglossi*, runs backwards above the hypoglossal nerve. At the posterior border of the hyoglossus the lingual vein is joined by the vena comitans hypoglossi and the venæ comites of the artery, if they are present; then it passes backwards to end either in the common facial vein or the internal jugular vein.

Ligamentum Stylohyoideum.—The stylo-hyoid ligament is the last structure to be examined in this dissection. It is a fibrous cord which springs from the tip of the styloid process and passes antero-inferiorly to be attached, under cover of the hyoglossus muscle, to the lesser cornu of the hyoid bone. It is not uncommon to find it partially ossified; in other cases it may assume a ruddy hue and contain muscular fibres.

OTIC GANGLION AND TENSOR VELI PALATINI.

During the dissection of the submaxillary region the dissector noted a nerve ganglion, *the submaxillary ganglion*, connected with the lingual branch of the mandibular nerve; and, when he was examining the infratemporal region, reference was made to the otic ganglion, which is associated with the trunk of the mandibular nerve and the branch which it supplies to the internal pterygoid muscle. The otic ganglion and its connections should now be displayed, and afterwards the tensor veli palatini muscle should be cleaned and followed from its origin downwards to the hamulus of the medial pterygoid lamina.

Dissection.—Cut the lingual and inferior alveolar nerves immediately below their origins; evert the upper part of the mandibular nerve, and define the otic ganglion; then divide the internal pterygoid, along the posterior border of the lateral pterygoid lamina; depress the lower part of the muscle and clean the tensor veli palatini, which lies medial to the middle meningeal artery, the otic ganglion and the mandibular nerve, and separates them from the lateral surface of the auditory tube.

Ganglion Oticum.—The otic ganglion is a minute, oval body, not easily found. It lies immediately below the foramen ovale, between the mandibular nerve laterally, the tensor veli palatini medially, and the middle meningeal artery posteriorly; it is intimately associated with the origin of the nerve to the internal pterygoid (Fig. 66).

The otic ganglion is usually described as receiving motor, sensory, and sympathetic roots. The *motor root* is supplied by the nerve to the internal pterygoid muscle; the *sympathetic root* comes from the plexus around the middle meningeal artery. In addition to those roots, the *lesser superficial petrosal nerve* enters the posterior border of the ganglion, and conveys *sensory fibres* to it.

The following are the *branches* which proceed from the otic ganglion:—

Branches of distribution.	A twig which passes downwards and forwards to the tensor veli palatini. (O.T. Tensor palati.)
	A twig which proceeds upwards and backwards to supply the tensor tympani.
Connecting branches.	One or more fine filaments to one or both of the roots of the auriculo-temporal nerve.
	A minute communicating filament to the chorda tympani.

Musculus Tensor Veli Palatini.—The tensor of the soft palate is a flat, triangular muscle which is closely applied to the deep surface of the internal pterygoid muscle. It arises from the scaphoid fossa at the root of the medial pterygoid lamina, from the posterior border of the lower surface of the great wing of the sphenoid, from the spine of the sphenoid, and from the lateral aspect of the auditory tube (O.T. Eustachian). It descends to the lower end of the medial pterygoid lamina, and ends in a tendon which turns horizontally, under the hamulus, into the soft palate, where its attachments will be seen later when the soft palate is dissected.

THE GREAT VESSELS AND NERVES OF THE NECK.

As soon as the dissection of the infratemporal and the submaxillary regions is completed, the dissector should turn to the study of the external carotid artery and its relations.

Arteria Carotis Externa.—The external carotid artery is one of the two terminal branches of the common carotid. It commences at the level of the upper border of the thyreoid cartilage, opposite the fibro-cartilage between the third and fourth cervical vertebræ; and, after running upwards and backwards to the level of the neck of the mandible, it terminates, between that portion of bone and the upper part of the antero-medial surface of the parotid gland, by dividing into two terminal branches—the superficial temporal and the internal maxillary arteries. At its commencement it lies anterior and medial to the internal carotid artery; and it is called external because it is distributed mainly to the parts on the exterior of the skull. It is, at first, comparatively superficial in the upper part of the carotid triangle; next, it passes under cover of the lower part of the postero-medial surface of the parotid gland, and the posterior belly of the digastric and the stylo-hyoid muscles. At the upper border of the stylo-hyoid it enters a groove in the medial border of the parotid, through which it passes to the upper part of the antero-medial surface of the gland, behind the neck of the mandible, where it terminates (Figs. 51, 73, 74).

Relations.—As it lies in the carotid triangle it is covered by the skin, superficial fascia and platysma, branches of the nervus cutaneus colli and the cervical branch of the facial nerve, and the deep fascia. Beneath the deep fascia it is crossed superficially by the common facial and lingual veins

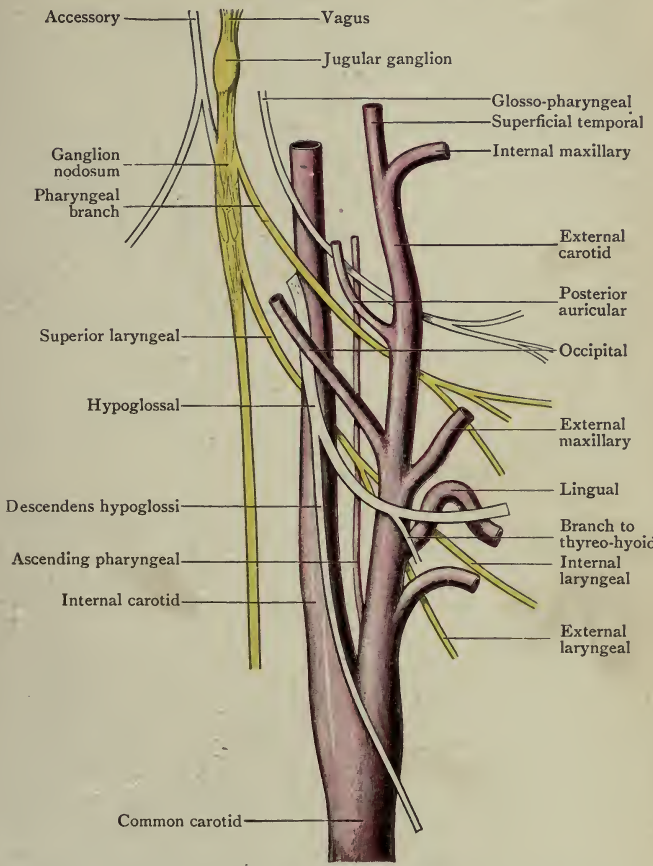


FIG. 73.—Diagram of Carotid System of Vessels in the Neck, with the Glosso-pharyngeal, Vagus, Accessory, and Hypoglossal Nerves.

and the hypoglossal nerve; and, at the upper end of the triangle, it is concealed by the lower end of the parotid gland, and it is crossed, from behind forwards, by the posterior facial vein. After it leaves the carotid triangle it is overlapped by the angle of the mandible, and is crossed by the posterior belly of the digastric and the stylo-hyoid. At its termination it is concealed by the upper part of the parotid and is crossed by branches of the facial nerve.

To its medial side lies the wall of the pharynx with the external and internal laryngeal branches of the superior laryngeal nerve intervening in the region of the carotid triangle. The medial relations, at a higher level, will be seen to greater advantage at a later stage, when the styloid process is detached and displaced. They are the pharyngeal branch of the vagus, the stylo-pharyngeus, the glosso-pharyngeal nerve, and the styloid process or the stylo-hyoid ligament. Those structures lie to its medial side as they pass obliquely between it and the internal carotid, which has gradually attained a plane posterior and medial to that in which the external carotid lies.

In the whole of its extent the external carotid is accompanied by numerous sympathetic nerve fibres, derived from the upper cervical sympathetic ganglion; they constitute the *external carotid plexus*, which distributes offsets along all the branches of the artery.

Branches.—The branches of the external carotid artery are —the superior thyreoid, the lingual, and the external maxillary, from its anterior aspect; the occipital and the posterior auricular, from its posterior aspect; the ascending pharyngeal, from its medial side; and the superficial temporal and the internal maxillary are its terminal branches.

Arteria Thyreoidea Superior.—The superior thyreoid artery arises, within the carotid triangle, from the anterior aspect of the external carotid close to its origin. It runs downwards and forwards, under cover of the omo-hyoid, sterno-hyoid, and sterno-thyreoid muscles, to the apex of the corresponding lobe of the thyreoid gland, where it ends by breaking up into three terminal branches.

The following branches proceed from it:—

1. Hyoid.
2. Superior laryngeal.
3. Sterno-mastoid.
4. Crico-thyreoid.
5. Terminal glandular.

Ramus Hyoideus.—The hyoid branch is a small twig, which springs from the superior thyreoid in the carotid triangle. It runs along the lower border of the hyoid bone, under cover of the thyreo-hyoid muscle, and anastomoses with its fellow of the opposite side, and with the hyoid branch of the lingual artery.

Arteria Laryngea Superior.—The superior laryngeal artery is a larger vessel. It springs from the superior thyreoid in the carotid triangle, and, associating itself with the internal laryngeal nerve, it pierces the thyreo-hyoid membrane, enters the pharynx, and descends to the larynx (Fig. 68).

Arteria Sternocleidomastoidea.—The sterno-mastoid branch is a small vessel which runs downwards and backwards, across the carotid sheath, along the upper border of the anterior belly of the omo-hyoid muscle, to reach the deep surface of the sterno-mastoid muscle, into which it sinks. It gives, in addition, minute twigs to the depressor muscles of the larynx.

Ramus Cricothyreoideus.—The crico-thyreoid artery runs medially, upon the crico-thyreoid ligament, and anastomoses with its fellow of the opposite side. It has already been noticed in the dissection of the middle line of the neck (p. 129).

Rami Glandulares.—The glandular rami are the three terminal branches. They spring from the main trunk at the apex of the lobe of the thyreoid gland. The largest branch is distributed on the medial surface of the lobe; the smallest branch ramifies on its lateral surface; whilst the third branch runs downwards upon the anterior border of the lobe, and then along the upper border of the isthmus towards its fellow of the opposite side. The medial and lateral branches are not uncommonly replaced by a posterior trunk which runs along the posterior border of the lobe. The anastomosis between the thyreoid arteries of the two sides is by no means free.

Venæ Thyreoideæ Superiores.—The superior thyreoid veins emerge from the gland and form a trunk which receives tributaries corresponding in a great measure with the branches of the artery. It crosses the upper part of the common carotid artery and joins the internal jugular vein.

Arteria Lingualis.—The lingual artery springs from the external carotid at the level of the greater cornu of the hyoid bone in the carotid triangle. It runs along the upper border of the greater cornu. As its name indicates, it is the artery of supply to the tongue. It has already been dissected in the carotid triangle and the submaxillary region, and the details of its course and relations are given on p. 197.

Arteria Maxillaris Externa (O.T. **Facial Artery**).—The

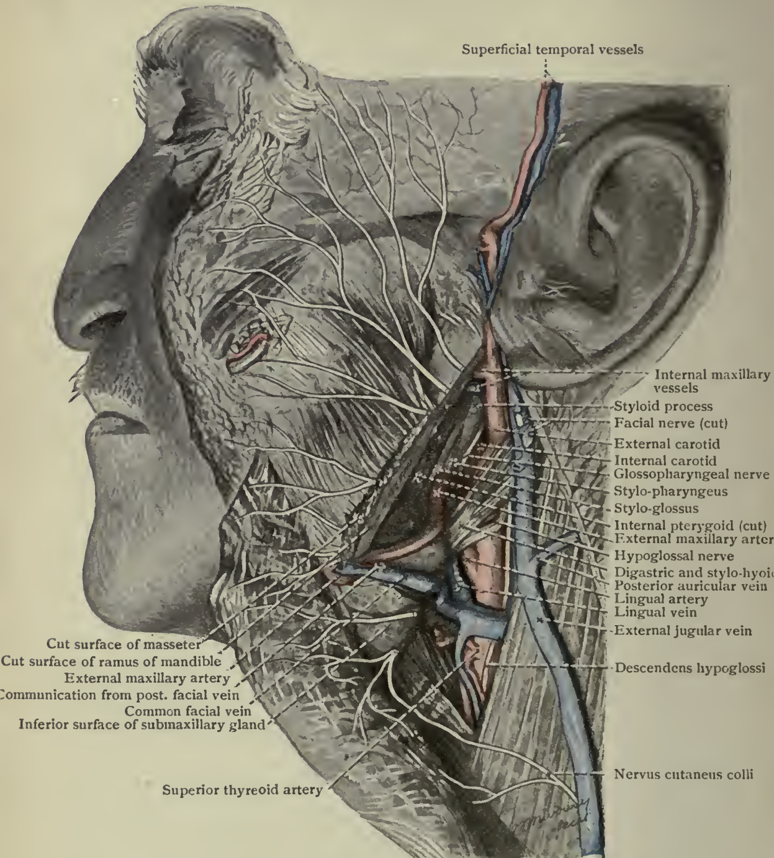


FIG. 74.—Dissection to show the relations of the External Carotid Artery and the deep part of the External Maxillary Artery. The parotid gland and the posterior part of the ramus of the mandible and the muscles attached to it have been removed. The terminal branches of the facial nerve have been cut and the terminal parts left *in situ*.

In this specimen the greater part of the posterior facial vein joined the external jugular vein. The lingual vein joined the common facial vein; and the origin of the external maxillary artery was deep to the posterior belly of the digastric muscle.

cervical part of the external maxillary artery can be studied at the present stage of the dissection. The artery arises from the anterior aspect of the external carotid, immediately above the lingual, in the upper part of the carotid triangle, and passes vertically upwards, on the lateral surface of the middle constrictor muscle of the pharynx, to the angle of the mandible, where it disappears under cover of the posterior belly of the digastric and the stylo-hyoid muscle. At that point the superior constrictor is medial to it and separates it from the palatine tonsil. At the upper border of the stylo-hyoid it enters a deep groove in the posterior part of the submaxillary gland, in which it runs downwards and forwards between the lateral surface of the gland and the internal pterygoid muscle, then turning round the lower border of the mandible at the anterior border of the masseter it enters the face (Fig. 74). For details of its course in the face see p. 16.

The named branches which spring from the external maxillary artery before it enters the face are:—

1. Ascending palatine.
2. Tonsillar.
3. Glandular.
4. Submental.

Arteria Palatina Ascendens.—The ascending palatine branch is given off for the supply of the soft palate, but it distributes branches to the palatine tonsil and auditory (O.T. Eustachian) tube also. It ascends between the stylopharyngeus and stylo-glossus muscles, and will be better seen when the styloid process is reflected (p. 210).

Ramus Tonsillaris.—The tonsillar branch runs upwards between the internal pterygoid and stylo-glossus muscles, then turns medially, pierces the superior constrictor, and enters the palatine tonsil.

The *glandular branches* are given to the submaxillary gland, as the external maxillary artery passes through it.

Arteria Submentalis.—The submental artery is a branch of some size. It arises close to the lower border of the mandible, and runs towards the chin, superficial to the mylohyoid muscle. Near the symphysis it changes its direction, and is carried upwards over the lower border of the mandible, to end in branches for the muscles and integument of the chin and lower lip. In the submaxillary region it gives numerous twigs to the surrounding muscles and glands, and anastomoses with the sublingual artery by branches which pierce the mylo-hyoid muscle. It anastomoses, in the face, with the inferior labial branches of the external maxillary and the mental branch of the inferior alveolar.

Vena Facialis Anterior.—The *cervical portion* of the anterior facial vein has already been seen (p. 130) passing backwards and downwards, superficial to the submaxillary

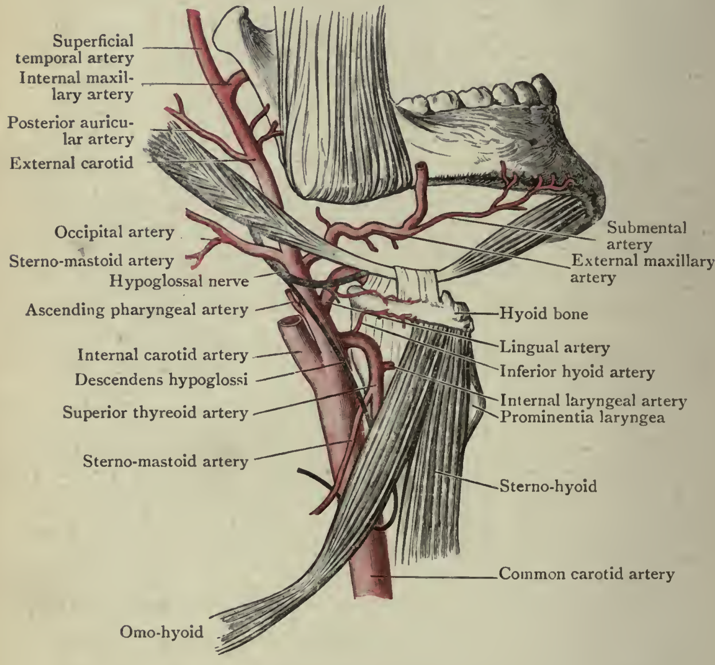


FIG. 75.—Diagram of the External Carotid Artery and its Branches. The right half of the mandible is tilted up.

gland. After receiving tributaries corresponding to the branches of the corresponding part of the external maxillary artery, it joins the posterior facial vein. The short trunk thus formed is termed the *common facial vein*, and it pours its blood into the internal jugular at the level of the hyoid bone.

Arteria Occipitalis.—The occipital artery springs from the posterior aspect of the external carotid artery, at the same level as the external maxillary. It takes the lower border of the posterior belly of the digastric muscle as its guide, and runs upwards and backwards, under cover of the sterno-mastoid muscle, and, generally, under cover of the lower border of the posterior belly of the digastric, to reach the interval between the mastoid portion of the base of the skull and the transverse process of the atlas. Thence onwards, it has been studied in the dissection of the scalp and the back of the neck (pp. 47, 56). The first part of the vessel crosses the internal carotid artery, the vagus nerve, the accessory nerve, the internal jugular vein, and the hypoglossal nerve, which hooks round it.

The only branches which spring from the occipital artery in the region under consideration are: (1) muscular twigs; and (2) a meningeal branch.

The *muscular twigs* are given to the neighbouring muscles. One of them, the *sterno-mastoid branch*, is larger than the others and very constant, runs parallel with the accessory nerve, and sinks, with it, into the substance of the sterno-mastoid muscle.

A *meningeal branch* associates itself with the internal jugular vein, and can be followed upwards upon it to the jugular foramen, through which it passes into the cranium.

Arteria Auricularis Posterior.—The posterior auricular artery will be found above the level of the posterior belly of the digastric, and, like the occipital, it takes origin from the posterior aspect of the external carotid artery. In the first part of its course it is placed deeply, and runs upwards and backwards, between the styloid process of the temporal bone and the postero-medial surface of the parotid gland, to reach the interval between the mastoid process and the back of the auricle. Then it accompanies the posterior auricular nerve in the superficial fascia of the scalp, where its course has already been studied, in the dissection of the scalp (p. 47).

As it runs upwards and backwards the posterior auricular artery gives off (1) muscular twigs; (2) a few branches to the parotid gland; and (3) the stylo-mastoid artery.

Arteria Stylomastoidea.—The stylo-mastoid artery is a slender vessel which enters the stylo-mastoid foramen. In the interior of the temporal bone it has an extensive distribution. It supplies twigs to the mastoid cells and to the tympanic cavity, and is carried onwards, in the canalis facialis (O.T. Fallopian), to anastomose with the petrosal branch of the middle meningeal.

Arteria Maxillaris Interna.—The commencement of the internal maxillary artery, from the termination of the external carotid, between the neck of the mandible and the antero-medial surface of the parotid gland, has been seen already, and the artery has been traced through the infratemporal region to the pterygo-palatine fossa, where its terminal branches will be dissected at a later period.

Arteria Temporalis Superficialis. — Like the internal maxillary, the superficial temporal artery commences between the neck of the mandible and the antero-medial surface of the parotid gland. It passes upwards, and, as it emerges from under cover of the upper end of the parotid gland, it pierces the parotid fascia, crosses superficial to the posterior end of the zygomatic arch, and enters the superficial fascia of the scalp, in which it ascends, on the superficial surface of the temporal fascia, and anterior to the auricle (Figs. 51, 76). It breaks up into two branches, *frontal* and *parietal*. The two branches anastomose with each other and with their fellows of the opposite side. The frontal branch anastomoses with the supra-orbital and frontal branches of the ophthalmic also, and the parietal branch anastomoses with the posterior auricular and the occipital arteries. Whilst it is still under cover of the parotid it gives branches to the gland; *anterior auricular branches* to the auricle; the *transverse facial*, which passes along the lower border of the zygomatic arch, across the masseter. As the superficial temporal crosses the zygoma it gives off a *zygomatico-orbital branch*, which runs to the lateral border of the orbit, and a *middle temporal branch*, which perforates the temporal fascia and anastomoses in the temporal fossa with the deep temporal branches of the internal maxillary. The course of the middle temporal branch (Fig. 76) and the distribution of the terminal branches have been followed in earlier stages of the dissection (pp. 48, 169).

Dissection.—Divide the posterior belly of the digastric immediately below its origin, and turn it downwards and forwards towards the hyoid bone; then examine the stylo-pharyngeus muscle. It may be necessary to cut the occipital and posterior auricular arteries in order to gain free access to the deeper parts, but that should not be done unless it is unavoidable. Care must be taken whilst cleaning the stylo-pharyngeus to avoid injuring the glosso-pharyngeal nerve, which turns round its posterior border and crosses its superficial surface.

Musculus Stylopharyngeus.—The stylo-pharyngeus is the longest of the three slender muscles which spring from the styloid process. It arises from the deep or medial surface of the process, close to its root, and extends downwards and

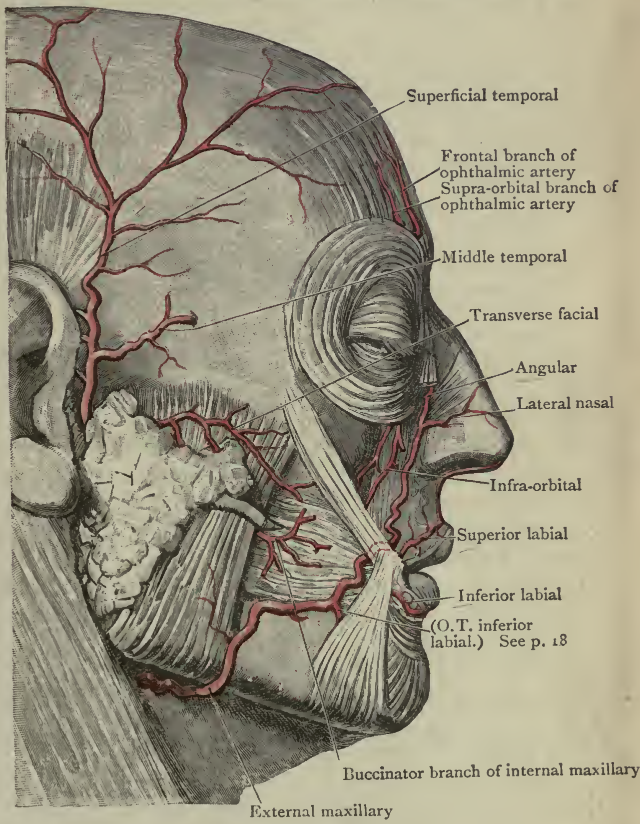


FIG. 76.—Arteries of the Face.

forwards to gain the side of the pharynx, where it disappears under cover of the upper border of the middle constrictor muscle. Whilst under cover of the middle constrictor its fibres blend with those of the pharyngo-palatinus, and, with them, are inserted into the posterior border of the corresponding lamina of the thyreoid cartilage. It is supplied by the glosso-pharyngeal nerve. If the dissector removes the fascia at the posterior part of the thyreo-hyoid space he will expose the lower fibres of the middle and the upper fibres of the inferior constrictor, and in the interval between them, on a deeper plane, the lateral surface of the lower part of the stylo-pharyngeus. It is an elevator of the larynx.

Dissection.—Snip through the base of the styloid process with the bone forceps, and throw it and the attached muscles downwards and forwards. The upper parts of the internal carotid artery and internal jugular vein are now exposed, and the ascending pharyngeal and ascending palatine arteries can be followed to the base of the skull.

If the external carotid is pushed forwards and the internal carotid is pulled backwards the ascending pharyngeal artery will be seen, in a well-injected subject, lying in the areolar tissue between the two carotid arteries and on a deeper plane. It must be cleaned and followed to the base of the skull.

Arteria Pharyngea Ascendens.—The ascending pharyngeal artery springs from the medial surface of the external carotid artery, close to its lower end, and is its smallest branch. It ascends along the lateral border of the pharynx, lying between the stylo-pharyngeus laterally and the constrictors of the pharynx medially, first in a plane between the external and internal carotid arteries, and then to the medial side of the internal carotid. As it passes upwards it gives *pharyngeal branches* to the wall of the pharynx, and *prevertebral branches* to the prevertebral muscles. At the base of the skull it gives off *meningeal branches*, which enter the cranial cavity through the hypoglossal canal, the jugular foramen, and the foramen lacerum; and *palatine branches*, which pierce the pharyngeal aponeurosis, above the upper border of the superior constrictor, and descend, along the levator veli palatini, to the soft palate. Offsets from the latter branches are given to the auditory tube (O.T. Eustachian) and to the palatine tonsil.

Arteria Palatina Ascendens.—After the ascending palatine artery has passed between the stylo-glossus and the stylo-pharyngeus (see p. 205), it ascends, along the side of the pharynx, to the petrous part of the temporal bone. There it pierces the pharyngeal aponeurosis, and then it accompanies the levator veli palatini to the soft palate. It helps to supply the soft palate, the palatine tonsil, the wall of the pharynx, and the auditory tube.

Dissection.—After the ascending pharyngeal artery has been examined, the *internal carotid artery*, the *glosso-pharyngeal, vagus, accessory*, and *hypoglossal nerves*, and the *superior cervical ganglion*, with their various connections and branches, must be dissected. A dense and tough fascia envelops them, and a great amount of patience is required to trace the branches of the nerves through it. One nerve—*the pharyngeal branch of the vagus*—which proceeds downwards and forwards, upon the superficial or lateral aspect of the internal carotid, is especially liable to injury, and must therefore be borne in mind from the very outset of the dissection. The *internal laryngeal* and the *external laryngeal nerves* have been previously displayed in the anterior triangle of the neck. If they are traced upwards, they will lead to the *superior laryngeal branch* of the vagus, which lies in relation with the deep aspect of the internal carotid artery. Near the base of the skull all the nerve-trunks will be found making their appearance, close together, in the interval between the internal jugular vein and the internal carotid artery; whilst posterior to the vein the *rectus lateralis muscle* and the *first loop* of the *cervical plexus* will be seen.

Arteria Carotis Interna.—The internal carotid artery is one of the two terminal branches of the common carotid, and it commences, therefore, at the level of the upper border of the thyreoid cartilage. From that point it proceeds upwards in the neck, in a vertical direction, until it reaches the base of the skull; there it disappears from view by entering the carotid canal of the petrous portion of the temporal bone. Through the carotid canal it reaches the interior of the cranium. The internal carotid artery can therefore be very appropriately divided into three parts—viz., (1) a cervical; (2) a petrous; and (3) an intracranial. The cervical part alone comes under the notice of the student in the present dissection.

In the first part of its extent the internal carotid artery lies in the carotid triangle, and is therefore comparatively superficial. It is covered by the integument, platysma, and fascia, and is overlapped by the sterno-mastoid muscle and the anterior border of the internal jugular vein. It is crossed by the hypoglossal nerve, the occipital artery and its sterno-mastoid branch, and the lingual and common facial veins. The descendens hypoglossi descends on its superficial surface.

As it proceeds upwards, it passes under cover of the lower end of the parotid gland and then at a higher level under cover of the posterior belly of the digastric, the stylo-hyoid, the stylo-pharyngeus, and the styloid process, which separate it from the postero-medial surface of the parotid gland. It will be noted also that *three nerves* and *three arteries* cross the vessel superficially, viz. :—

1. The hypoglossal nerve.
2. The glosso-pharyngeal nerve.
3. The pharyngeal branch of the vagus nerve.

1. The occipital artery.
2. The sterno-mastoid branch of the occipital artery.
3. The posterior auricular artery.

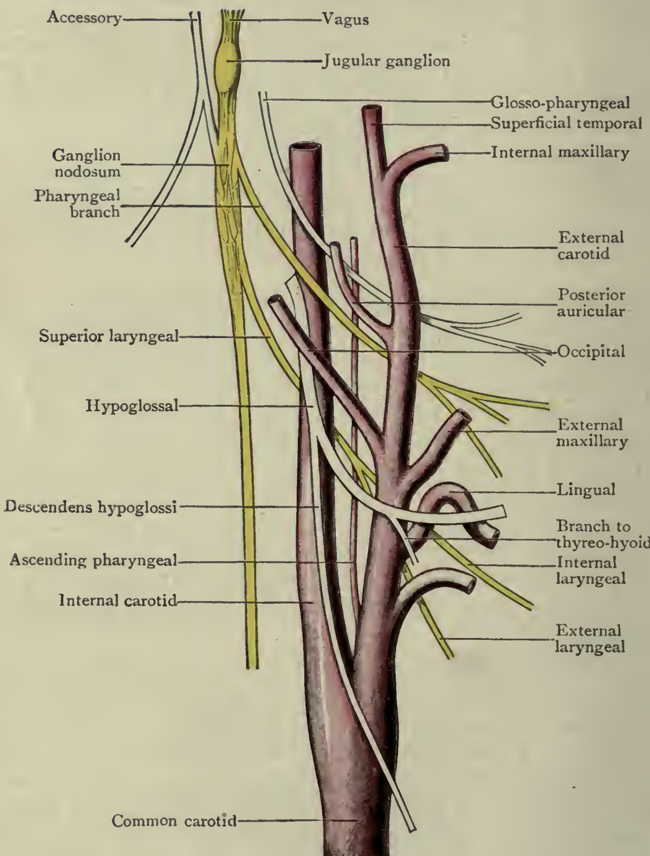


FIG. 77.—Diagram of Carotid System of Vessels in the Neck, with the Glosso-pharyngeal, Vagus, Accessory, and Hypoglossal Nerves.

The hypoglossal nerve, as already noted, crosses it in the carotid triangle; the other nerves cross it under cover of the posterior belly of the digastric. The occipital artery crosses it at the level of the lower border of the posterior belly of the digastric, the posterior auricular, at the level of the upper border of that muscle, and the sterno-mastoid branch of the occipital artery at the point where the hypoglossal nerve turns forwards.

The relationship of the external carotid artery to the internal carotid is a varying one. At first the external carotid lies antero-medial to the internal carotid; but soon, owing to its inclination backwards, it comes to lie superficial to the internal carotid. The following structures intervene between the two vessels :—

1. Styloid process.
2. Stylo-pharyngeus muscle.
3. Glosso-pharyngeal nerve.
4. Pharyngeal branches of vagus and sympathetic.
5. A portion of the parotid gland.

Posterior to the internal carotid are the longus capitis (O.T. rectus capitis anticus major) and the sympathetic trunk; postero-laterally are the glosso-pharyngeal, the vagus, the accessory and the hypoglossal nerve; and still more laterally and posteriorly is the internal jugular vein. On its *medial aspect* the internal carotid is related to the constrictors of the pharynx, the ascending pharyngeal artery and the levator veli palatini.

Before leaving the internal carotid artery, note that, near the base of the skull, four nerves appear in the interval between it and the internal jugular vein; they are the glosso-pharyngeal, the vagus, the accessory, and the hypoglossal.

Vena Jugularis Interna.—The internal jugular vein is the largest venous channel of the neck. It enters the neck through the postero-lateral compartment of the jugular foramen, where it is directly continuous with the transverse blood sinus of the cranium. From the jugular foramen it proceeds downwards, until it reaches the posterior aspect of the medial end of the clavicle, where it joins the subclavian vein to form the innominate vein (Fig. 78). Its commencement in the jugular foramen shows a slight dilatation, termed *the bulb*, the lumen of which remains at all times patent owing to the connection of walls of the bulb to the margins of the foramen. The skull cap should be removed and a probe should be passed from the transverse sinus into the internal jugular vein, to demonstrate the continuity of the two channels.

Relations.—At its commencement the internal jugular

PLATE VII

FIG. 78.—Dissection of the Head and Neck of the same subject as that shown in Fig. 15, but the greater part of the parotid gland, the greater part of the sterno-mastoid muscle, the greater part of the external jugular vein, portions of other veins, portions of the sterno-hyoid and sterno-thyreoid muscles, and the submaxillary gland have been removed to display deeper structures.

1. Supra-orbital artery and nerve.
2. Frontal artery and vein.
3. Lateral nasal branch of external maxillary artery.
4. Superior labial branch of external maxillary artery.
5. Inferior labial branch of external maxillary artery.
6. External maxillary artery.
7. External maxillary artery.
8. Deep part of submaxillary gland.
9. Lingual artery.
10. Submental branch of external maxillary artery.
11. Mylo-hyoid muscle.
12. Nerve to thyreo-hyoid muscle.
13. Internal laryngeal nerve.
14. Common facial vein.
15. Superior thyreoid vessels.
16. Common carotid artery and descendens hypoglossi nerve.
17. Sterno-hyoid muscle.
18. Omo-hyoid muscle (anterior belly).
19. Sterno-thyreoid muscle.
20. Thyreoid gland.
21. Middle thyreoid vein.
22. Trachea.
23. Inferior thyreoid vein.
24. Sterno-thyreoid muscle.
25. Sterno-hyoid muscle.
26. Subclavius muscle with nerve.
27. Cephalic vein.
28. Lateral anterior thoracic nerve.
29. Acromial branch of thoraco-acromial artery.
30. Transverse scapular vessels.
31. First serration of serratus anterior muscle.
32. Subclavian artery.
33. Transverse cervical artery.
34. Upper root of long thoracic nerve.
35. Trapezius.
36. Scalenus anterior.
37. Internal jugular vein.
38. Communicans hypoglossi nerve.
39. Ascending branch of transverse cervical artery.
40. Internal carotid artery.
41. External carotid artery.
42. Hypoglossal nerve.
43. Occipital artery and sterno-mastoid branch.
44. Lesser occipital nerve.
45. Digastric and stylo-hyoid muscles.
46. Third occipital nerve.
47. Greater occipital nerve and occipital artery.
48. Posterior auricular artery and vein.
49. Superficial temporal vessels and auriculo-temporal nerve.

PLATE VII

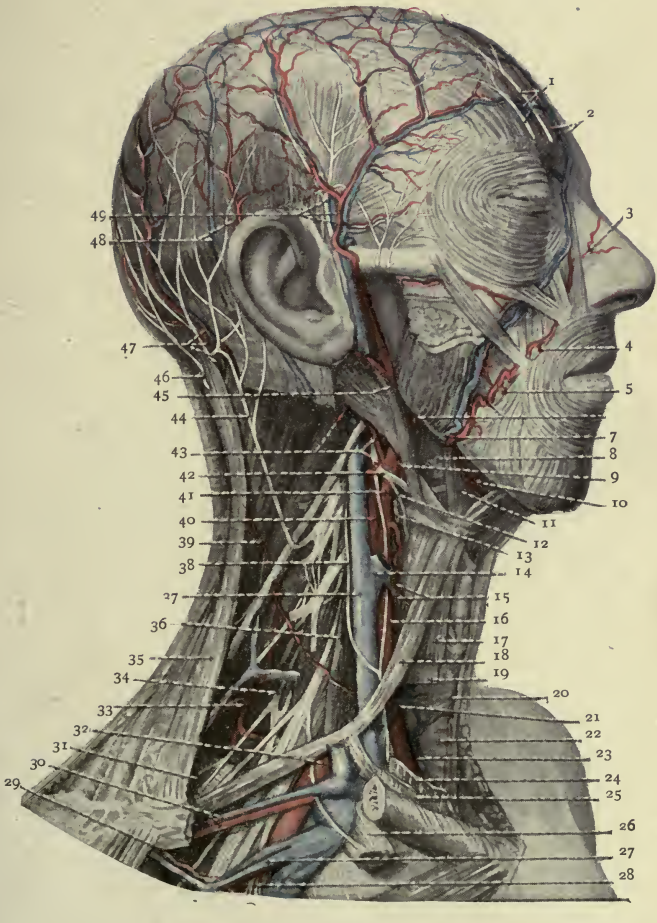


FIG. 78.

vein lies postero-lateral to the upper end of the cervical part of the internal carotid artery, from which it is partially separated by the last four cerebral nerves. As it descends it assumes a more directly lateral relationship, first to the internal carotid and then to the common carotid, overlapping each vessel to a slight extent anteriorly; and it is enclosed, with them and the vagus nerve, in a common sheath of deep cervical fascia, the nerve lying in its own compartment of the sheath between the vein laterally and the arteries medially, and in a posterior plane (Figs. 47, 48, 53).

The superficial or lateral relations of the vein in the upper part of its extent are the styloid process, with the stylo-

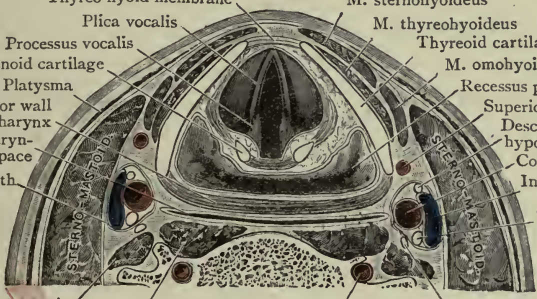


FIG. 79.—Transverse section through the Neck at the level of upper part of Thyreoid Cartilage.

pharyngeus and stylo-hyoid muscles, and the posterior belly of the digastric, which separate it from the upper part of the postero-medial surface of the parotid gland. In that part of its extent it is crossed superficially, along the upper border of the posterior belly of the digastric, by the posterior auricular artery, and at the lower border of the digastric by the accessory nerve, passing downwards and backwards, and by the occipital artery, passing upwards and backwards, superficial to the nerve. At a slightly lower level it is concealed by the lower part of the postero-medial surface of the parotid, and it is crossed by the sterno-mastoid branch of the occipital artery. After it emerges from under cover of the parotid, it lies under cover of the anterior border of the sterno-mastoid, except in the region of the upper part of the carotid triangle, where it may project forwards, beyond the anterior border of the muscle, for a short distance. It is separated from the sterno-mastoid by numerous deep cervical lymph glands; and under cover of the muscle it is crossed superficially, at the level of the upper part of the thyreoid cartilage, by the communicans cervicalis from the cervical plexus, and, at the level of the cricoid cartilage, by the intermediate tendon of the omo-hyoid, the sterno-mastoid branch of the superior thyreoid artery and the nerve to the posterior belly of the omo-hyoid. Below the omo-hyoid it is covered by the posterior border of the sterno-hyoid, and is

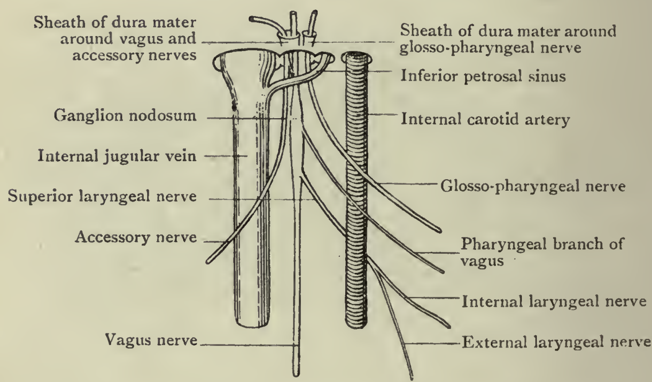


FIG. 80.—Diagram of the relation of parts in the Jugular Foramen.

crossed by the anterior jugular vein; and at its termination it lies posterior to the sternal end of the clavicle.

Posteriorly, it is in relation with the rectus capitis lateralis; the rectus capitis anterior (O.T. anticus minor); and the loop between the first and second cervical nerves. At a lower level its posterior relations are the transverse processes of the cervical vertebræ and the muscles attached to their anterior tubercles, viz., the longus capitis (O.T. rectus capitis anticus major) and the scalenus anterior. Between its posterior surface and the scalenus anterior are the ascending cervical artery, the phrenic nerve, and, crossing superficial to the latter, the transverse cervical and the transverse scapular arteries. On the left side the terminal part of the thoracic duct also crosses the phrenic nerve posterior to the internal jugular vein. At the medial border of the scalenus anterior the thyreo-cervical trunk is posterior to it, and, at a lower level, the first part of the subclavian artery and the dome of the pleura.

The right vein is usually the larger of the two; and as they approach the root of the neck both veins incline slightly to the right, with the result that, on the right side, the lower part of the vein is separated from the common carotid artery by a small triangular interval bounded below by the subclavian artery, whilst on the left side the vein overlaps the anterior aspect of the common carotid artery.

Tributaries.—Immediately below its commencement the internal jugular vein is joined by the inferior petrosal sinus, and then, successively, by offsets from the pharyngeal plexus, by the lingual veins, the common facial vein, and the superior and middle thyreoid veins. In some cases it is joined near its upper end by a *vena comitans* which runs with the occipital artery; and, occasionally, near its lower end, it receives the lymph trunks which usually open into the commencement of the innominate vein.

> ***Dissection.***—Slit open the lower part of the vein and examine the valve which lies close to its extremity. It consists of two or three semilunar flaps which prevent regurgitation of blood from the innominate vein into the internal jugular.

Nervi Glosso-pharyngeus, Vagus et Accessorius.—After the removal of the brain the glosso-pharyngeal, vagus, and accessory nerves were seen leaving the cranial cavity, through the middle compartment of the jugular foramen, in the interval between the commencement of the internal jugular vein postero-laterally and the inferior petrosal sinus antero-medially (p. 111, and Fig. 81, p. 218). The dissector should again examine the interior of the cranial cavity and refresh his memory as to the manner in which the nerves enter the foramen. The *glosso-pharyngeal* occupies the most anterior position, and it is cut off from the others by a separate, tube-like sheath of dura mater. The *accessory* is placed posterior to the *vagus*, and both are included within the same sheath of dura mater. They therefore traverse the foramen in close contact with each other. Reaching the exterior of the skull, the three become associated with the hypoglossal nerve; and the four nerves lie, for a short distance, in the interval between the internal jugular vein and the internal carotid artery, but soon they choose different routes. The *accessory* inclines backwards, superficial or deep to the internal jugular vein; the *glosso-pharyngeal* runs forwards, superficial to the internal carotid, and under cover of the posterior belly of the digastric; at a lower level, the hypoglossal also turns forwards across the internal and external carotid arteries; and the *vagus* proceeds

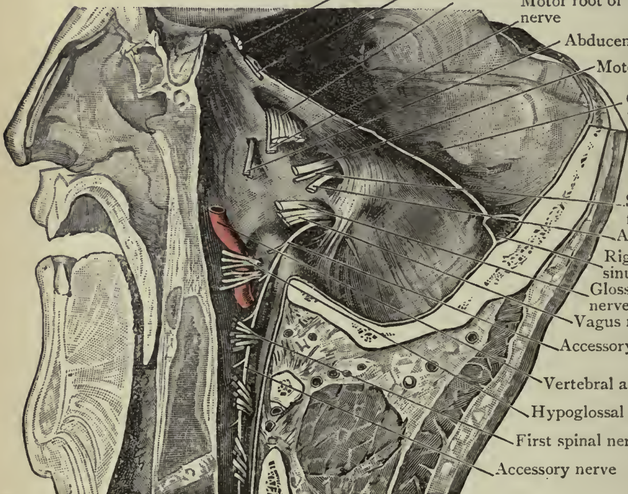


FIG. 81.—Section through the Head a little to the right of the Median Plane. It shows the posterior cranial fossa and the upper part of the vertebral canal after the removal of the brain and the medulla spinalis.

vertically downwards, first between the internal jugular vein and the internal carotid artery, and then between the vein and the common carotid artery (Fig. 79).

In an ordinary dissection it is impossible to follow out many of the minute twigs which take origin from the last four cerebral nerves in the region of the basis cranii. To do so it is necessary to possess a perfectly fresh part which has been specially prepared by having the soft parts toughened with spirit and the bone softened by immersion in a weak solution of acid. Even then the dissection is a difficult one, but it should be undertaken by the advanced student, in the event of his being able to obtain a part for the purpose.

In the following description of the nerves the account of the branches which can in all cases be traced is printed in *ordinary type*, whilst that of those requiring special dissection is printed in *small type.*

Nervus Glosso-pharyngeus.—The glosso-pharyngeal nerve inclines downwards and forwards and crosses the internal carotid artery superficially. At first it lies medial to the styloid process and the stylo-pharyngeus muscle, then it hooks round the lower border of the muscle and curves forwards across its superficial surface to gain the base of the tongue. In the dissection of the submaxillary region, its terminal part was seen disappearing under cover of the hyoglossus muscle, where it ends in *lingual branches* (Fig. 68).

In the present dissection an attempt should be made to secure the following branches:—

1. Communicating branch from the facial.
2. Nerve to the stylo-pharyngeus.
3. Pharyngeal.
4. Tonsillar.
5. Lingual.

The *communicating branch from the facial* springs from the nerve to the posterior belly of the digastric, and, as a rule, emerges from amidst the fibres of that muscle to join the glosso-pharyngeal close to the lower part of the jugular foramen.

The *stylo-pharyngeal nerve* is a small twig which enters the muscle of the same name. The greater part of its fibres, however, are continued through the muscle to the mucous membrane of the pharynx.

The *pharyngeal branches* consist of—(1) one or two small twigs which perforate the superior constrictor to reach the mucous membrane of the pharynx; and (2) a larger nerve which comes off higher up and passes with the pharyngeal branch of the vagus to the pharyngeal plexus. It frequently divides into two or more branches.

The *tonsillar branches* proceed from the glosso-pharyngeal near the base of the tongue. They form a plexus, over the palatine tonsil, termed the *circulus tonsillaris*, and give twigs to the mucous membrane of the isthmus faucium and the soft palate as well as to the tonsil. Look up. p

The *terminal* or *lingual branches* will be followed in the dissection of the tongue.

There are still other points in connection with the glosso-pharyngeal nerve which require mention. At the lower part of the jugular foramen two small ganglia are formed upon its trunk, and from the lower of the two certain minute branches are given off. The upper ganglion is called the *ganglion superius*; the lower one is termed the *ganglion petrosum.*

The *superior ganglion* is a small ganglionic swelling, which involves only a portion of the fibres of the nerve trunk. It is placed in the upper part of the bony groove in which the nerve lies as it proceeds through the jugular foramen. No branches arise from it.

The *petrous ganglion* is a larger swelling, which involves the entire nerve-trunk, and lies at the opening of the jugular foramen, between the vagus nerve and the inferior petrosal sinus (which intervenes between it and the anterior border of the foramen). Its length is not more than four or five millimetres. Three branches of communication enter or proceed from it and connect it with—(1) the superior cervical sympathetic ganglion; (2) the auricular branch of the vagus; and (3) the jugular ganglion of the vagus.

In addition to the twigs mentioned, the *tympanic nerve* takes origin from the petrous ganglion.

Nervus Tympanicus.—The ultimate destination of the tympanic nerve may be regarded as the otic ganglion, but it takes a very circuitous route to gain that structure, and it gives off branches on the way. It enters a small foramen on the ridge which separates the jugular fossa from the carotid foramen on the lower surface of the petrous bone, and it is conducted by a narrow canal to the tympanic cavity. It crosses the medial wall of that chamber, grooving the promontory. Having gained the anterior part of the tympanum, it enters the bone a second time, and runs in a minute canal, which tunnels the petrous bone below the upper end of the channel which lodges the tensor tympani muscle. In that part of its course the tympanic nerve is joined by a branch from the ganglion geniculi of the facial nerve, and, after the junction is effected, it is termed the *lesser superficial petrosal nerve.*

The canal in which the *lesser superficial petrosal nerve* is lodged opens, by a small aperture, into the cranial cavity, upon the anterior surface of the petrous bone, immediately lateral to the hiatus canalis facialis. Through the aperture the nerve enters the cranial cavity, and it almost immediately leaves it by passing downwards in the interval between the great wing of the sphenoid and the petrous part of the temporal bone, or through the canaliculus innominatus, or through the foramen ovale. Outside the skull it joins the otic ganglion.

In the tympanic cavity the *tympanic nerve* gives branches of supply —(1) to the mucous membrane of the tympanum; (2) to the lining membrane of the mastoid cells; and (3) to the mucous membrane of the auditory tube (Eustachian). It is connected with the sympathetic plexus on the internal carotid artery by the *superior* and *inferior carotico-tympanic branches* which pierce the substance of the petrous part of the temporal bone and form with the tympanic nerve the *tympanic plexus.*

Nervus Vagus.—The vagus nerve passes through the middle compartment of the jugular foramen in company with the accessory nerve—both being included within the same sheath of dura mater. In the neck, it pursues a vertical course, lying, at first, between the internal jugular vein and the internal carotid artery, and afterwards between the same vein and the common carotid artery, enclosed within the sheath which envelops the vessels, but on a plane posterior to them. Its posterior relations, therefore, are similar to those of the common and internal carotid arteries (pp. 117, 211). At the root of the neck it enters the thorax, and has different relations on the two sides. On the *right side* it crosses the first part of the subclavian artery; on the *left side*, after crossing anterior to the thoracic duct, it proceeds downwards between the left common carotid and subclavian arteries, posterior to the left innominate vein. For its thoracic relations see Vol. II. p. 127.

The vagus, like the glosso-pharyngeal, has two ganglia in connection with its upper part. These are the *ganglion jugulare* and the *ganglion nodosum.*

Ganglion Jugulare (O.T. **Ganglion of Root**).—The jugular ganglion is situated within the jugular foramen. It is a rounded swelling which is connected by communicating twigs with several of the nerves in the neighbourhood, and it gives off two branches of distribution.

Branches of Communication.—(1) With the facial nerve; (2) with the petrous ganglion of the glosso-pharyngeal; (3) with the accessory; (4) with the superior ganglion of the sympathetic.

Branches of Distribution.—(1) Meningeal; (2) Auricular nerve.

The *meningeal branch* is a minute twig which runs upwards through the jugular foramen, and, dividing into two branches, is distributed to the dura mater in the posterior cranial fossa.

The *auricular nerve* (O.T. Arnold's nerve) obtains a filament of communication from the petrous ganglion of the glosso-pharyngeal, and passes backwards, upon the lateral surface of the bulb of the internal jugular vein, to enter a minute aperture on the posterior part of the lateral wall of the jugular fossa. A narrow canal then conducts it through the substance of the temporal bone, and, on its way, it crosses the canalis facialis a short distance above the stylo-mastoid foramen. It is thus brought into close relation with the facial nerve and is connected with it by an ascending and a descending branch of communication. Finally, it appears on the surface of the skull, in the interval between the mastoid process and the external acoustic meatus, where it communicates with the posterior auricular branch of the facial. It supplies the skin on the posterior aspect of the outer surface of the wall of the meatus, the skin covering the lower half of the inner surface of the wall of the meatus, and the lower half of the tympanic membrane.

Ganglion Nodosum.—After emerging from the jugular foramen, the vagus nerve is joined by the *cerebral portion* of the *accessory nerve*, and swells out into the ganglion nodosum (O.T. ganglion of trunk).

The *ganglion nodosum* is an elongated reddish-coloured swelling, about 18 mm. (three-quarters of an inch) in length, which is developed upon the stem of the vagus, 12.5 mm. (half an inch) below the base of the cranium. Strong branches of communication pass between it and the first loop of the cervical plexus, and the superior cervical ganglion of the sympathetic. Further, the hypoglossal nerve is generally closely bound to it by fibrous attachment, in the midst of which some interchange of nerve filaments takes place.

Branches of Distribution of the Cervical Part of the Vagus.—The branches which spring from the vagus as it traverses the neck are the following: (1) pharyngeal; (2) superior laryngeal; (3) recurrent; (4) cardiac.

Ramus Pharyngeus.—The pharyngeal branch springs from the upper part of the ganglion nodosum and runs downwards and forwards, superficial to the internal carotid artery, to end in the *pharyngeal plexus.* It is frequently replaced by two branches, of which the upper is the larger.

Nervus Laryngeus Superior.—The superior laryngeal nerve, a much larger branch, arises from the middle of the ganglion nodosum. It passes downwards and forwards, but differs from the pharyngeal branch by passing deep to the internal carotid artery. Whilst in that situation it ends by dividing into the *internal laryngeal* and *external laryngeal nerves*, both of which have been previously seen in the dissection of the anterior triangle (p. 132).

Before it divides, the superior laryngeal effects communications, by means of fine twigs, with the superior cervical ganglion of the sympathetic, and it also receives one or two filaments from the pharyngeal plexus.

The *internal laryngeal nerve* runs to the interval between the hyoid bone and the thyreoid cartilage; there, after disappearing under cover of the posterior border of the thyreo-hyoid muscle, it pierces the membrane of the same name, and enters the pharynx, and then descends to the larynx.

The *external laryngeal nerve* is a very slender branch, which inclines downwards and forwards to reach the crico-thyreoid muscle, in which it ends.

It supplies a few filaments to the inferior constrictor of the pharynx and a fine twig to the superior cardiac branch of the sympathetic, whilst it receives a communicating branch from the superior cervical ganglion of the sympathetic.

Nervus Recurrens.—The recurrent nerve arises differently on the two sides. On the *right side*, after springing from the vagus as the latter crosses the first part of the subclavian artery, it hooks round the artery and ascends to its termination. On the *left side*, it arises from the vagus, in the thorax, and hooks round the aortic arch. In the neck, each recurrent nerve ascends in the groove between the trachea and œsophagus, along the medial side of the corresponding lobe of the thyreoid gland, and, passing posterior or anterior to the inferior thyreoid artery, it disappears, as *the inferior laryngeal nerve*, under cover of the lower border of the inferior constrictor muscle, and enters the larynx.

Before the recurrent nerve reaches the larynx it gives off several branches — viz., (1) cardiac branches; (2) twigs to the trachea and œsophagus; and (3) a few filaments to the inferior constrictor, as it passes under cover of its lower margin.

Cardiac Branches.—Two cardiac branches arise from the vagus in the neck. On the *right side*, both of them enter the thorax by passing posterior to the subclavian artery, and they end in the deep cardiac plexus. On the *left side*, the *upper nerve* joins the deep cardiac plexus, whilst the *lower nerve* enters into the formation of the superficial cardiac plexus.

Nervus Accessorius.—The accessory nerve consists of two parts—a *spinal* and a *cerebral*. In the jugular foramen the *cerebral portion* is connected by one or two fine twigs with the jugular ganglion of the vagus, and below the base of the skull it leaves the spinal part and joins the vagus.

The *cerebral part* of the accessory nerve contributes to the vagus the greater proportion of its motor fibres. They pass over the surface of the ganglion nodosum, and are continued into the pharyngeal and into the superior laryngeal nerves. Some of the fibres are carried down the stem of the vagus into the cardiac branches and also into the recurrent nerve.

The *spinal part* of the accessory is directed backwards below the level of the transverse process of the atlas. It crosses the internal jugular vein, and disappears into the sterno-mastoid muscle. Its further course has been studied already (pp. 41 and 133). It is distributed to two muscles —viz., the sterno-mastoid and the trapezius.

Plexus Pharyngeus.—The pharyngeal plexus is a meshwork of fine nerve filaments, which is formed upon the wall of the pharynx at the level of the middle constrictor muscle. The pharyngeal branches of the vagus, glosso-pharyngeal, and superior cervical ganglion of the sympathetic enter into its construction, and one or more minute ganglia are developed in connection with it. Its terminal twigs are given to the muscles and mucous membrane of the pharynx, and one branch (the *ramus lingualis vagi*) connects the plexus with the hypoglossal nerve.

Nervus Hypoglossus.—The hypoglossal nerve makes its exit from the cranium through the hypoglossal canal (O.T. anterior condyloid foramen). It pierces the dura mater in two separate parts, which unite into one stem at the external orifice of the bony canal. As it issues from the canal it lies deeply, medial to the internal jugular vein and the internal carotid artery; immediately afterwards it inclines laterally, and, taking a half spiral turn around the ganglion nodosum of the vagus, it appears between the two vessels, and descends between them to the lower border of the posterior belly of the digastric muscle, where it passes into the carotid triangle. Its close connection with the ganglion nodosum of the vagus has been noted already (p. 221). In the carotid triangle, it hooks round the lower end of the occipital artery, below its sterno-mastoid branch, and, turning forwards, it crosses superficial to the occipital, the internal and external carotid arteries and the loop of the lingual artery. Then it passes across the medial sides of the posterior belly of the digastric and the stylo-hyoid, and enters the digastric triangle, where it disappears medial to the mylo-hyoid; and at the anterior border of the hyoglossus it enters the root of the tongue.

Branches of Communication.—Near the base of the skull the hypoglossal nerve is connected with—(1) the superior cervical ganglion; (2) the vagus; and (3) the first cervical nerve; as it turns round the occipital artery it receives (4) the *ramus lingualis vagi* from the pharyngeal plexus; and on the surface of the hyoglossus it communicates with (5) the lingual nerve by one or more branches (p. 195).

Branches of Distribution.—(1) The *meningeal branch* arises in the upper part of the canalis hypoglossi, and, regaining the interior of the cranium, it is distributed to the dura mater around the foramen magnum. (2) *Vascular twigs* are said to be supplied to the deep aspect of the internal jugular vein. (3) The *descendens hypoglossi*, which conveys fibres of the first cervical nerve to the infra-hyoid muscles. (4) The *nerve to the thyreo-hyoid*, which also consists of first cervical nerve fibres. (5) The *terminal branches*, which supply the genio-hyoid and all the intrinsic and extrinsic muscles of the tongue, except the glosso-palatinus.

Dissection.—In the preceding dissections of the neck the greater part of the cervical sympathetic, and the branches which proceed from it, have been displayed. The inferior ganglion, which lies deeply, in the hollow between the transverse process of the seventh cervical vertebra and the neck of the first rib, is still to a certain extent concealed, and must now be displayed. Dislodge the subclavian artery from its place on the first rib behind the scalenus anterior muscle, and turn it medially. To do that efficiently, it will be necessary to cut the costo-cervical artery at its origin. Great care must be taken to preserve uninjured the fine nerves which proceed downwards anterior to the first part of the subclavian artery. If more space for the dissection is required, the anterior part of the first rib may be removed by the bone-forceps, but, as a general rule, that will not be necessary.

Truncus Sympathicus in the Neck.—The cervical part of the sympathetic trunk takes a vertical course through the neck, anterior to the roots of the transverse processes of the vertebræ. It lies between the internal and common carotid arteries anteriorly and the longus capitis (O.T. rectus capitis anticus major) and longus colli muscles posteriorly. *Above*, it is prolonged upwards in the form of a stout, ascending nerve-trunk, *the nervus caroticus internus*, which accompanies the internal carotid artery into the carotid canal; *below*, it becomes continuous, over the neck of the first rib and posterior to the apex of the pleura, with the thoracic portion of the sympathetic trunk. Only three ganglia are developed upon the cervical part of the trunk and no white rami communicantes from the cervical nerves enter either the trunk or the ganglia.

Ganglion Cervicale Superius.—The superior cervical ganglion, the largest of the three ganglia, is an elongated fusiform body which varies somewhat in size. It is placed upon the upper part of the longus capitis, opposite the second and third cervical vertebræ, and posterior to the carotid sheath. From its upper end the stout nervus caroticus internus passes into the carotid canal, whilst its lower end tapers downwards into the trunk. Numerous branches issue from it; some of them connect it with neighbouring nerves, whilst others are distributed in various ways.

The connecting branches are: (1) slender *grey rami communicantes* which connect it with the upper four cervical nerves; (2) twigs to both ganglia of the vagus; (3) to the petrous ganglion of the glosso-pharyngeal; and (4) to the hypoglossal. It is not connected with the accessory.

The branches of distribution are: (1) nervus caroticus internus; (2) nervi carotici externi; (3) rami laryngo-pharyngei; (4) nervus cardiacus superior.

Nervus Caroticus Internus.—The internal carotid nerve passes from the upper end of the ganglion into the carotid canal. Its distribution will be considered later (p. 241).

Nervi Carotici Externi.—Two to six filaments, called external carotid branches, run to the external carotid artery, and form a loose interlacement around it called the *external carotid plexus* from which a branch is given to the glomus caroticum, and prolongations are continued on all the branches of the artery. The part continued upon the external maxillary artery supplies the sympathetic root to the submaxillary ganglion, whilst the subdivision upon the middle meningeal artery furnishes the corresponding root to the otic ganglion, as well as the *external superficial petrosal nerve*, which runs to the ganglion geniculi of the facial nerve.

Rami Laryngo-pharyngei.—The laryngo-pharyngeal branches join the pharyngeal plexus and the superior laryngeal nerve.

Nervus Cardiacus Superior.—The superior cardiac nerve is a long slender branch which springs, by several roots, from the ganglion, and then proceeds downwards, posterior to the carotid artery. At different stages of its course it is joined by other branches of the sympathetic, by a branch from the vagus, and also by filaments from the external laryngeal and recurrent nerves. The *right superior cardiac nerve* is continued into the thorax by passing posterior or anterior to the subclavian artery, and it ends in the deep cardiac plexus. The *left superior cardiac nerve* follows the left common carotid artery in the thorax, and, after crossing the left side of the arch of the aorta, ends in the superficial cardiac plexus.

Ganglion Cervicale Medium.—The middle cervical ganglion is the smallest of the three ganglia of the neck. It is placed opposite the sixth cervical vertebra, in close proximity to the inferior thyreoid artery, upon which it not infrequently rests. Its branches are: (1) *grey rami communicantes*, which pass between the contiguous margins of the scalenus anterior and longus colli muscles and connect the ganglion with the *fifth* and *sixth cervical nerves*; (2) *thyreoid branches*, which run to the thyreoid gland, along the inferior thyreoid artery, and form connections with the external laryngeal and recurrent nerves; (3) the middle cardiac nerve.

On both sides *the middle cardiac nerve* enters the thorax and is lost in the deep cardiac plexus. On the *right side*, it passes posterior or anterior to the subclavian artery; on the *left side*, it is continued downwards between the common carotid and subclavian arteries.

Ganglion Cervicale Inferius.—The inferior cervical ganglion is lodged in the interval between the transverse process of the seventh cervical vertebra and the neck of the first rib. In that position it lies posterior to the vertebral artery. It is by no means uncommon to find it more or less completely fused, over the neck of the first rib, with the first thoracic ganglion. The connection between it and the middle cervical ganglion is generally in the form of two or more slender nerve cords. One of the cords passes anterior to the subclavian artery, loops round below it and ascends behind it. That loop is termed the *ansa subclavia* (Vieussenii).

The branches of the inferior cervical ganglion are:—

1. Grey rami communicantes to the seventh and eighth cervical nerves.
2. Rami vasculares.
3. Nervus cardiacus inferior.

The *vascular rami* are fine branches which form a plexus around the subclavian artery and its branches. Those around the vertebral artery are remarkable for their large size.

The *inferior cardiac nerve*, on both sides, enters the deep cardiac plexus.

Thyreoid Gland—Trachea—Œsophagus.

After the vessels and nerves of the neck have been studied the dissectors should examine the thyreoid gland, the trachea, and the œsophagus.

Glandula Thyreoidea.—The thyreoid gland is a highly vascular, solid body, which clasps the upper part of the trachea and extends upwards for some distance upon each side of the larynx. It is enclosed in a sheath of the pre-tracheal layer of the cervical fascia, which is attached above to the front and sides of the larynx. It possesses also its own proper fibrous capsule, which is continuous with the stroma of the gland. Between the sheath and the capsule the arteries of supply ramify before they enter the gland substance, and the emerging veins anastomose with one another to form the various thyreoid veins. It varies greatly in size in different subjects; and in females and children it is always relatively larger than in adult males. It consists of three well-marked subdivisions, viz., two lobes joined across the median plane by the isthmus. Each *lobe* is somewhat conical in form; its base lies at the level of the fifth or the sixth tracheal ring, whilst its apex rests against the side of the thyreoid cartilage. Its *superficial* or *lateral surface* is full

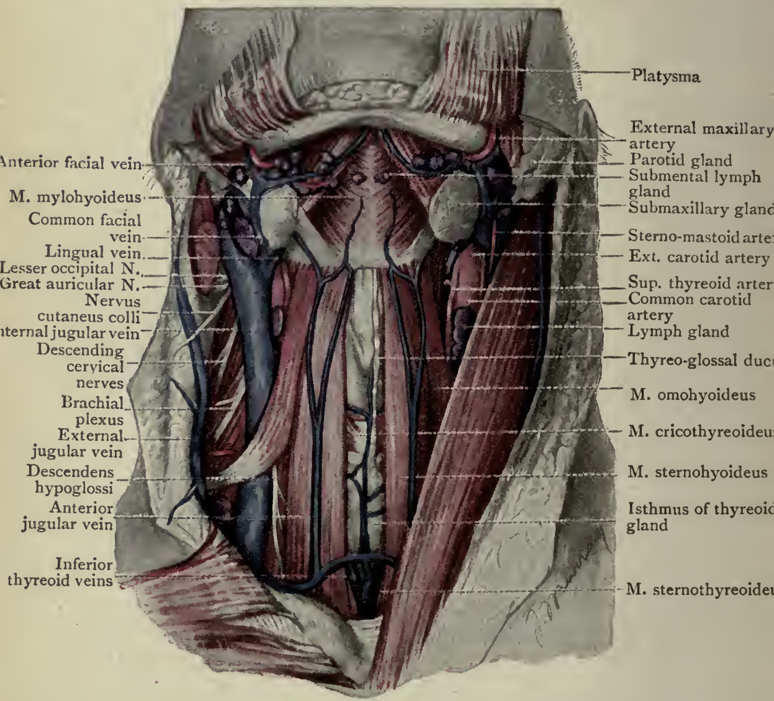


FIG. 82.—Dissection of the Anterior Part of the Neck. The Right Sterno-mastoid has been removed.

and rounded; it is covered superficially by the sterno-thyreoid, sterno-hyoid, and omo-hyoid muscles, and is overlapped by the anterior border of the sterno-mastoid (Fig. 83, p. 230). Its *deep* or *medial surface* is adapted to the parts upon which it lies, viz., to the side of the trachea, the cricoid cartilage, and the thyreoid cartilage. Its *posterior border* is in relation with the lateral margins of the œsophagus and the pharynx, and the recurrent nerve. In most cases it overlaps the common carotid artery. Its anterior border is connected with the anterior border of the opposite lobe by the isthmus. Above the isthmus it is in relation with the anterior terminal branch of the superior thyreoid artery, and, below the isthmus, with the commencement of the inferior thyreoid vein.

The *isthmus* of the thyreoid gland has already been seen in the dissection of the middle line of the neck. It is a band of varying width which lies anterior to the second, third, and fourth rings of the trachea, and, therefore, nearer the lower than the upper ends of the two lobes.

An additional lobe, the *pyramidal* or *middle lobe*, is frequently present. It is an elongated slender process which springs from the isthmus, on one or other side of the median plane (more usually on the left side), and extends upwards towards the hyoid bone. It may be connected to the hyoid bone by fibrous tissue, or by a narrow slip of muscular fibres called the *levator glandulæ thyreoideæ.* That little muscle, in some cases, has an attachment to the thyreoid gland independently of the pyramidal process. The thyreoid gland is firmly connected by fascia to the parts upon which it lies, and therefore follows the larynx in all its movements.

The dissector should note the great vascularity of the thyreoid gland. Four large arteries, and occasionally a fifth smaller vessel, convey blood to its substance. At the apex of each lobe a superior thyreoid branch of the external carotid artery divides into three branches which supply the gland; the two *inferior thyreoid branches*, from the thyreocervical trunks of the subclavian arteries, distribute their terminal branches to the basal portions and deep surfaces of the two lobes. The occasional artery is the *thyreoidea ima*, a branch of the innominate or, more rarely, of the common carotid or the aortic arch. It ascends, upon the anterior aspect of the trachea, to reach the isthmus of the thyreoid gland. These thyreoid arteries anastomose with one another.

The veins which drain the blood away from the thyreoid gland are still more numerous. They arise, in part, by tributaries which spring from a venous network on the anterior surface of the gland, but chiefly by branches which emerge from its substance. They are *three* in number on each side—viz., the superior thyreoid, the middle thyreoid, and the inferior thyreoid. The *superior and middle thyreoid veins* cross the common carotid artery and join the internal jugular; the *inferior thyreoid vein* descends on the trachea. At the root of the neck it usually joins its fellow of the opposite side to form a common stem which opens into the left innominate, in the thorax.

Trachea and Œsophagus.—The cervical portions of the windpipe and the gullet may now be studied. Both the trachea and the œsophagus begin at the level of the cricoid cartilage, anterior to the sixth cervical vertebra. From that

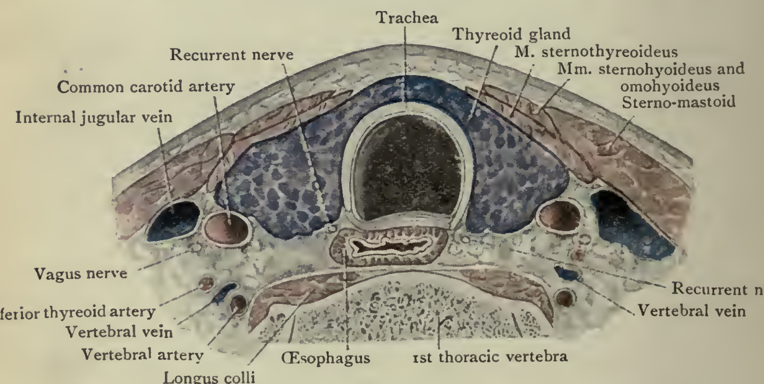


FIG. 83.—Transverse section through the Thyreoid Gland, Trachea, and Gullet, at the level of the first Thoracic Vertebra.

point they extend downwards, anterior to the vertebral column, to the thoracic cavity.

The *trachea*, or *windpipe*, is a wide tube which is kept constantly patent by the cartilaginous curved bars embedded in its walls. The bars do not form complete circles; posteriorly they are deficient, and, in consequence, the posterior surface of the trachea is flattened. The trachea is continuous above with the larynx, and, throughout its course in the neck, it is placed in the median plane of the body. The *anterior* relations of the trachea have already been fully discussed in the account of the parts which occupy the middle line of the neck (p. 127). *Posteriorly*, it rests upon the gullet. A common carotid artery and the corresponding lobe of the thyreoid gland lie upon each side of it, the lobe of the gland being closely applied to its upper part. A recurrent nerve ascends, on each side, in the angle between the trachea and œsophagus.

The *œsophagus* or *gullet* is a narrow tube, with thick muscular walls, which extends from the pharynx to the stomach. In the cervical part of its course it lies between the trachea and the longus colli muscles, and as it descends it inclines slightly to the left, so that it comes more closely into relation with the lobe of the thyreoid gland and the carotid sheath upon the left side than with the same structures on the opposite side (Figs. 54, 83, 108, 109).

The dissector may terminate his dissection of the neck by an examination of the scalene muscles and the rectus capitis lateralis muscle.

Scalene Muscles and Rectus Lateralis.

Musculi Scaleni.—The scalene muscles constitute the fleshy mass which is seen extending from the transverse processes of the cervical vertebræ to the upper two costal arches. They are three in number, and are named, from their relative positions, *anterior*, *medius*, and *posterior*.

Musculus Scalenus Anterior.—The scalenus anterior is a well-defined muscle which is separated from the scalenus medius by the roots of the brachial plexus and the subclavian artery. It arises from the anterior tubercles of the transverse processes of the third, fourth, fifth and sixth cervical vertebræ, and, tapering somewhat as it descends, it is inserted into the scalene tubercle on the inner margin of the first rib, and also into the superior surface of the same bone between the grooves for the subclavian artery and vein (Fig. 84).

The upper part of its *anterior surface* is concealed by the sterno-mastoid, and the lower part by the clavicle. The common carotid artery ascends along its medial border. Between it and the sterno-mastoid lie—(1) the internal jugular vein; (2) the intermediate tendon of the omo-hyoid; (3) the phrenic nerve, passing downwards and forwards; and (4) the transverse cervical and transverse scapular arteries, passing backwards and laterally, superficial to the phrenic nerve. Between it and the clavicle lies the subclavian vein.

Its *posterior surface* is in relation, above, with the tips of the lower cervical transverse processes, and below, with the apex of the pleura, the second part of the subclavian artery, and its costo-cervical branch. The *lateral border* touches the roots of the brachial plexus, and the *medial border* is in relation with the thyreo-cervical artery, its inferior thyreoid branch, and with the vertebral artery (Fig. 54).

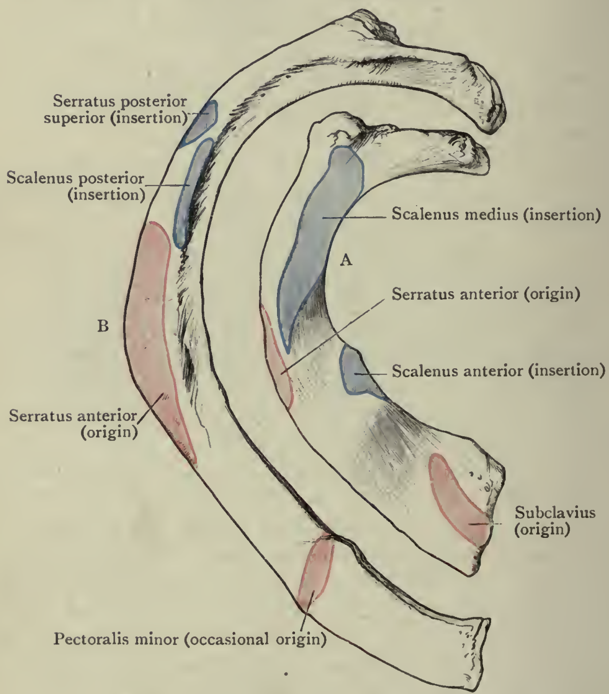


FIG. 84.—Muscle-Attachments to the Superior Surface of the First Rib, and the Outer Surface of the Second Rib.

A, First rib; B, Second rib.

Musculus Scalenus Medius.—The scalenus medius is a more powerful muscle than the scalenus anterior. It springs from the posterior tubercles of all the cervical transverse processes (with the exception, in some cases, of the first), and it is inserted into a rough oval impression which marks the upper surface of the first rib, between the tubercle of the rib and the groove for the subclavian artery (Fig. 84).

It forms part of the floor of the posterior triangle of the neck. Its superficial surface is in relation with the brachial plexus and the third part of the subclavian artery. Its posterior border touches the levator scapulæ; and the dorsal scapular nerve and the descending branch of the transverse cervical artery pass between it and that muscle. The lower part of its anterior border is in relation with the apex of the pleura, and the upper two roots of the long thoracic nerve pierce the substance of the muscle.

Musculus Scalenus Posterior. — The scalenus posterior is generally inseparable, at its origin, from the scalenus medius. It is the smallest of the three, and springs by two or three slips from the transverse processes of a corresponding number of the lower cervical vertebræ, in common with the scalenus medius. It is inserted into the upper border of the second rib, immediately anterior to the insertion of the levator costæ and behind the large rough area which marks the origin of the serratus anterior (Fig. 84).

The scalene muscles are supplied by twigs from the *anterior branches of the cervical nerves, particularly the lower four.* They elevated the ribs to which they are attached and are, therefore, muscles of thoracic respiration.

Dissection.—The little muscle termed the rectus capitis lateralis should now be cleaned, and its attachments defined. It lies in the interval between the transverse process of the atlas and the jugular process of the occipital bone, posterior to the commencement of the internal jugular vein. The anterior ramus of the first cervical nerve will be seen emerging from under cover of its medial margin.

Rectus Capitis Lateralis.—The rectus lateralis arises from the anterior part of the upper surface of the extremity of the transverse process of the atlas, and is inserted into the under surface of the jugular process of the occipital bone. It is supplied by a twig from the *anterior ramus of the first cervical nerve.*

Dissection.—By the time that the dissectors of the head and neck have arrived at this stage of their work, the dissectors of the thorax have, in all probability, finished their dissection. If that is the case, the head and neck may be removed from the trunk by cutting through the vertebral column at the level of the intervertebral fibro-cartilage between the third and fourth thoracic vertebræ. By this proceeding the upper three thoracic vertebræ, with the attached portions of the first, second, and third pairs of ribs, are removed with the neck. The scalene muscles and the longus colli are therefore preserved intact.

THE LATERAL PART OF THE MIDDLE CRANIAL FOSSA.

The structures contained within the middle cranial fossa may now be examined or re-examined. In carrying out this dissection, the head should be supported on a block so that the floor of the cranial cavity looks upwards. The following are the structures which must be displayed:—

1. Cavernous venous sinus.
2. Internal carotid artery.
3. Middle meningeal artery.
4. Accessory meningeal artery.
5. The two roots of the Trigeminal nerve, with the Semilunar ganglion and the three main divisions of the trigeminal nerve.
6. Oculo-motor nerve (3rd cerebral).
7. Trochlear nerve (4th cerebral).
8. Abducent nerve (6th cerebral).
9. Internal carotid plexus of the sympathetic.
10. Greater superficial petrosal nerve.
11. Lesser superficial petrosal nerve.

Dissection.—The dura mater has already been removed from one half of the middle cranial fossa (pp. 109, 110), and on that side it is necessary only to differentiate again the structures which lie in the cavernous sinus; on the other side the dura mater must be stripped from the medial part of the lateral portion of the middle cranial fossa. Enter the knife at the anterior clinoid process, and carry it backwards to the apex of the petrous bone. This incision must go no deeper than is necessary to divide the dura mater, and must be made immediately to the lateral side of the openings in the membrane through which the oculo-motor, the trochlear, and trigeminal nerves pass. It is very important to preserve those apertures intact, so that the proximal ends of the nerves may be held in position during the dissection. The incision through the dura mater may now be carried backwards and laterally along the upper border of the petrous bone in the line of the superior petrosal sinus, and, forwards and laterally, along the posterior margin of the small wing of the sphenoid. After the incisions are made, raise the dura mater with great care, for it is intimately connected with the nerves which lie subjacent to it. Thus, where it forms the lateral wall of the cavernous sinus, it is closely applied to the oculo-motor and trochlear nerves, and it is firmly attached to the ophthalmic division of the trigeminal nerve, whilst over the petrous bone it is united to the surface of the semilunar ganglion, and the greater and lesser superficial petrosal nerves are immediately beneath it. The edge of the knife, therefore, must be kept close to the membrane, and a small portion of the membrane may be left upon the nerves. The part which is left can be removed afterwards as the nerves are defined.

Sinus Cavernosus.—The cavernous sinus has been opened by the above dissection. It is a short, wide venous channel, which extends, along the side of the body of the sphenoid bone, from the lower and medial end of the superior orbital fissure (O.T. sphenoidal fissure) to the apex of the petrous portion of the temporal bone. Anteriorly, blood is conducted into it by the ophthalmic veins and the spheno-parietal sinus; whilst posteriorly, the blood is drained away by the superior and inferior petrosal sinuses. But it has still other connections. Thus, it receives blood from the lower part of the lateral surface of the brain by the superficial middle cerebral vein and some small inferior cerebral veins. It is united with the corresponding sinus of the opposite side by means of the

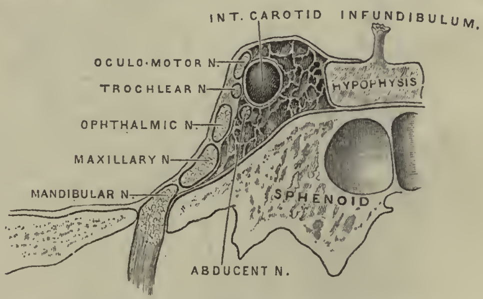


FIG. 85.—Section through the Cavernous Sinus. (After Merkel, somewhat modified.)

anterior and posterior intercavernous sinuses (p. 107). Lastly, one or more emissary veins leave its lower aspect; one passes out of the cranium by the foramen ovale, or it may be through the foramen Vesalii, and ends in the pterygoid venous plexus; and others accompany the internal carotid artery, through the foramen lacerum and the carotid canal, and end in the pharyngeal plexus.

The cavernous sinus is formed in the same manner as the other venous sinuses. The two layers of the dura mater are separated from each other, and the interval is lined with a delicate membrane. An intricate network of interlacing trabeculæ occupies the lumen of the channel, and it is on that account that the term "cavernous" is applied to the sinus. The cavernous sinus has a special importance on account of its being traversed by—the internal carotid artery;

the internal carotid plexus; the oculo-motor, trochlear, and abducent nerves; and the ophthalmic division of the trigeminal nerve. The precise relations which those structures bear to its walls will be described later; in the meantime it is necessary only to note that two, viz., the internal carotid artery and the abducent nerve, lie more distinctly within the interval between the two layers of the dura mater than the others, but that they are shut out from the blood channel by the delicate lining membrane of the sinus. The oculo-motor and trochlear nerves, and the ophthalmic division of the

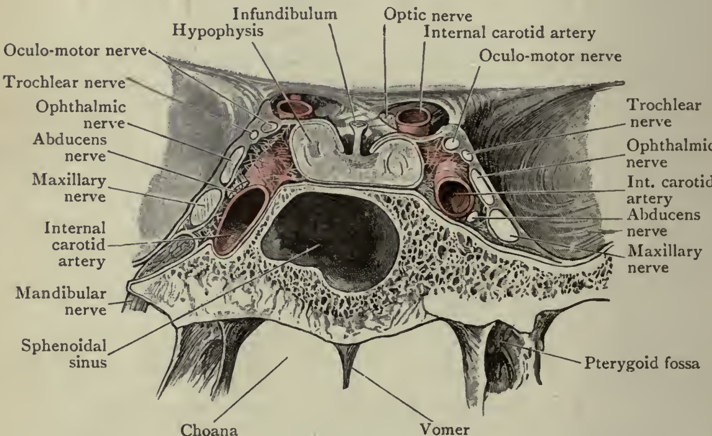


FIG. 86.—Frontal section through the Cavernous Sinus to show the position of the Nerves in its wall. Note the branch given to the hypophysis (O.T. pituitary body) by the internal carotid artery.

trigeminal nerve, are closely applied to the lateral wall of the sinus (Figs. 85, 86, 87, 92).

Nervus Trigeminus.—The two roots of the trigeminal nerve have already been seen passing between the two layers of the dura mater, at the apex of the petrous portion of the temporal bone, under the anterior margin of the tentorium. Now that the dura mater has been raised from the lateral part of the middle cranial fossa, the further relations of those nerve-roots within the cranium may be studied. It will be noticed that the loosely connected and parallel funiculi of the *portio major*, or sensory root, at once begin to divide and join with each other so as to form a dense plexiform arrangement, whilst, at the same time, the nerve-root increases somewhat in breadth. The interlacement, thus brought about, occupies the smooth depression which marks the anterior aspect of the apex of the petrous portion of the temporal bone, and it sinks into the semilunar ganglion (O.T. Gasserian).

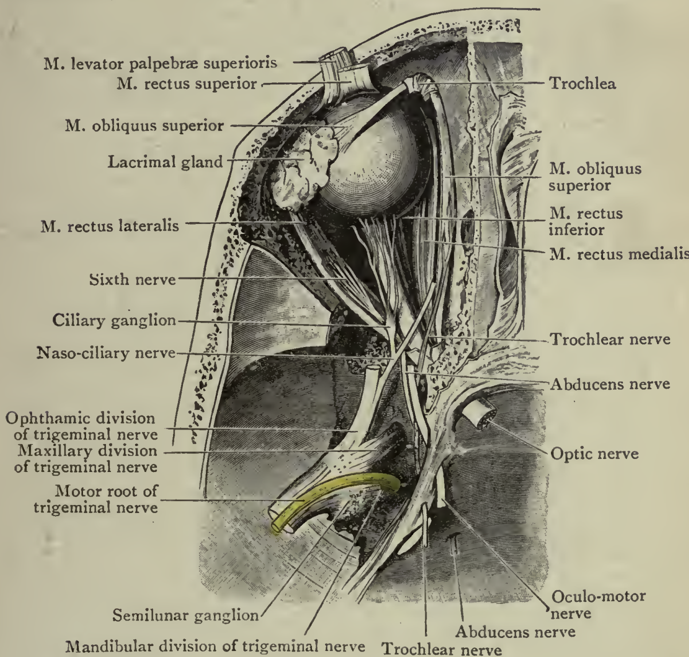


FIG. 87.—Dissection of the Orbit and the Middle Cranial Fossa. Both roots of the fifth nerve, with the semilunar ganglion, are turned laterally.

The *Semilunar Ganglion* (O.T. Gasserian) is somewhat crescentic in form. It lies upon the sutural junction between the apex of the petrous bone and the great wing of the sphenoid bone. There it is enclosed within a recess or space, called the *cavum Meckelii*, formed by a separation of the two layers of the dura mater. The concavity of the ganglion is directed postero-medially, and it is upon that aspect that it receives the interlacing fibres of the sensory root of the trigeminal nerve; the convexity of the ganglion is directed antero-laterally and from it emerge the three main divisions of the trigeminal nerve. They are—(1) the first, or ophthalmic division; (2) the second, or maxillary division; and (3) the third, or mandibular division. The medial border of the ganglion is connected with the internal carotid sympathetic plexus by filaments of communication.

The *portio minor*, or motor root, of the fifth nerve should now be followed. Before the nerve passes into Meckel's cave the motor root lies along the medial side of the large sensory root, but it soon changes its position and then lies beneath the sensory part. To display that relationship, draw the cut ends of the two roots through the aperture in the dura mater which leads into Meckel's cave, and, gently dislodging the semilunar ganglion from its place, turn it forwards and laterally so as to expose its deep surface. The small and firm motor root can readily be recognised lying in a groove on the deep surface of the ganglion; if it is displaced from the groove, it will be seen to have no connection with the ganglion, but to be continued onwards towards the foramen ovale. It ultimately joins the mandibular division of the trigeminal nerve. The junction may take place within the cranium, in the foramen ovale, or immediately outside the skull.

Dissection.—The three principal divisions of the trigeminal nerve may next be examined. Begin with the *mandibular division*, which is the largest. It proceeds directly downwards, and almost immediately leaves the cranial cavity through the foramen ovale.

Whilst isolating the mandibular division and defining the bony aperture through which it makes its exit, look carefully for the accessory meningeal artery, which enters the cranium through the same foramen. If the injection has been forced into the vessel it can easily be detected. An emissary vein which connects the cavernous sinus with the pterygoid venous plexus also passes through the foramen ovale.

The *maxillary division* is composed entirely of sensory fibres. It runs forwards, in relation to the lower and lateral part of the cavernous sinus, and, after a short course within the cranium, makes its exit through the foramen rotundum. Near its origin it gives off a fine *meningeal branch* to the dura mater of the middle fossa of the cranium.

The *ophthalmic division* is the smallest of the three branches of the trigeminal nerve, and, like the maxillary, it is composed entirely of sensory fibres. It passes forwards, in the lateral wall of the cavernous sinus, and ends, close to the superior orbital fissure, by dividing into three terminal branches. As it traverses the sinus it is accompanied by the oculomotor and trochlear nerves, both of which occupy a higher level. Like the other two divisions of the trigeminal nerve, the ophthalmic nerve gives off a *meningeal branch*; it is a small twig which passes into the tentorium cerebelli.

The terminal branches of the ophthalmic division of the trigeminal nerve are the naso-ciliary, the lacrimal, and the frontal. The *naso-ciliary*, as a rule, takes origin first; the *lacrimal* is given off soon after; and then the stem of the nerve is continued onwards as the *frontal*. The three branches enter the orbit through the superior orbital fissure.

Nervus Oculomotorius (Third), et Nervus Trochlearis (Fourth), et Nervus Abducens (Sixth).—It has been noted already that the *oculo-motor* nerve pierces the dura mater within the small triangular area, in the middle cranial fossa, which lies immediately anterior to the crossing of the attached and free margins of the tentorium (p. 108). It has been noted also that the *trochlear* (fourth) nerve pierces the dura mater in the posterior fossa under the free margin of the tentorium. Both proceed forwards in the lateral wall of the cavernous sinus. The oculo-motor nerve occupies the highest level, then comes the trochlear nerve, and immediately below that the ophthalmic division of the trigeminal nerve. The three nerves, therefore, present a numerical order from above downwards. The *abducent nerve*, which pierces the dura mater in the posterior fossa, at the lower and lateral part of the dorsum sellæ, curves round the lateral side of the internal carotid artery, and then passes forwards more directly within the cavernous sinus than the others (Fig. 85).

The oculo-motor, trochlear, and abducent nerves, during their course in the cavernous sinus, receive communications from the carotid plexus and from the ophthalmic nerve; and they all enter the orbit by passing through the superior orbital fissure. Before doing so, the oculomotor nerve divides into an upper and a lower division. As they pass through the superior orbital fissure the various nerves undergo a change in their relative positions. That, however, will be studied in the dissection of the orbit.

Arteria Carotis Interna.—The intracranial portion of the internal carotid artery may now be examined (Figs. 39, 85, 86, 92). It lies upon the lateral aspect of the body of the sphenoid, and, for the greater part of its course, it traverses the cavernous sinus. It emerges from the carotid canal into the foramen lacerum at the apex of the petrous bone; then it passes through the upper part of the foramen lacerum, pierces the outer layer of dura mater, and enters the middle cranial fossa, at the

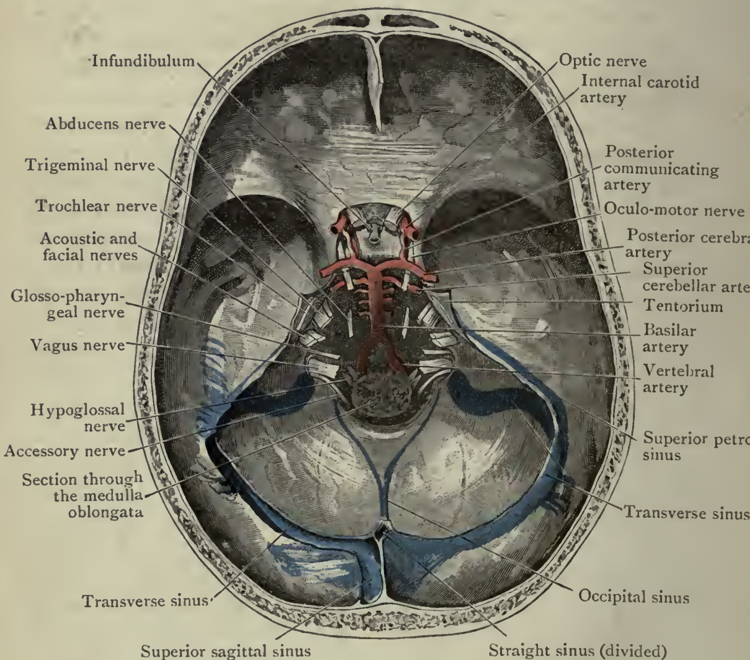


FIG. 88.—Floor of the Cranium after the removal of the Brain and the Tentorium Cerebelli. The blood vessels forming the circulus arteriosus have been left in place.

root of the posterior clinoid process; there it bends, at right angles, and passes forwards to the lower root of the small wing of the sphenoid, where it turns abruptly upwards and pierces the inner layer of the dura mater, immediately posterior to the entrance of the optic nerve into the optic foramen and on the medial side of the anterior clinoid process. It was severed at that point during the removal of the brain; but it will be afterwards seen to end, on the basal aspect of the brain, at the commencement of the lateral fissure (O.T. Sylvian fissure), by dividing into the anterior and middle cerebral arteries. Throughout its whole course it is surrounded by sympathetic filaments, and soon after its entrance into the cranium the abducent nerve crosses its lateral side.

The intracranial portion of the internal carotid artery gives off the following branches :—

1. Branches to the hypophysis, 2. Branches to the semilunar ganglion, 3. Branches to the dura mater,	These are minute twigs which arise in the cavernous sinus.
4. Ophthalmic, 5. Posterior communicating, 6. Anterior cerebral, } terminal 7. Middle cerebral, } branches. 8. Chorioidal.	These will be studied at a later stage.

Plexus Caroticus Internus.—The sympathetic filaments which form the internal carotid plexus can be satisfactorily dissected only in a subject which has not been injected; and even then, the dissection is an exceedingly difficult one. The *internal carotid plexus* is placed in the cavernous sinus and is massed chiefly upon the lower and medial aspect of the internal carotid artery, at the point where it makes its bend upwards. It supplies filaments to the hypophysis, to the third and fourth nerves, to the ophthalmic division of the trigeminal nerve and to the semilunar ganglion, and gives the sympathetic root to the ciliary ganglion (O.T. lenticular ganglion).

Nervus Petrosus Superficialis Major.—The greater superficial petrosal nerve, along with a small arterial twig from the middle meningeal artery, can readily be exposed in the groove, on the anterior face of the petrous bone, which leads from the hiatus canalis facialis to the foramen lacerum. It is placed under the semilunar ganglion, which must therefore be turned forwards and laterally. In the canalis facialis it joins the ganglion geniculi of the facial nerve. When traced in the opposite direction, it will be found to enter the foramen lacerum, where it joins the *deep petrosal nerve* from the carotid plexus. The trunk formed by the union of these two filaments is the *nerve of the pterygoid canal* (O.T. *Vidian nerve*).

Nervus Petrosus Superficialis Minor.—The lesser superficial petrosal nerve appears upon the anterior face of the petrous bone, through an aperture which is placed immediately lateral to the hiatus canalis facialis. It leaves the cranial cavity by passing downwards between the great wing of the sphenoid and the petrous part of the temporal bone, or through the canaliculus innominatus or through the foramen ovale, to reach the otic ganglion. It, as has been mentioned already (p. 220), is formed by the union of the tympanic branch of the glosso-pharyngeal with a branch from the ganglion geniculi of the facial.

External Superficial Petrosal Nerve.—It is convenient at this stage to take note of a fourth petrosal nerve—*the external superficial petrosal.* It takes origin from the sympathetic plexus which accompanies the middle meningeal artery, and, entering the petrous bone, is conducted to the ganglion geniculi of the facial nerve.

Middle and Accessory Meningeal Arteries.—The entrance of the *middle meningeal artery* through the foramen spinosum should now be examined. It gives minute twigs to the semilunar ganglion, and one—*the superficial petrosal artery*—which accompanies the greater superficial petrosal nerve into the hiatus canalis facialis. The further course of the middle meningeal artery has been described already (p. 118). The nervus spinosus, from the mandibular nerve, also enters the cranium through the foramen spinosum (p. 179).

The *accessory meningeal artery* enters the cranium through the foramen ovale, and is distributed chiefly to the semilunar ganglion.

THE ORBIT.

Within the orbital cavity the following structures are grouped around the eyeball and the optic nerve:—

Muscles, . . {
- Rectus superior.
- Rectus inferior.
- Rectus lateralis.
- Rectus medialis.
- Obliquus superior.
- Obliquus inferior.
- Levator palpebræ superioris.

Vessels, . . {
- Ophthalmic artery and its branches.
- Ophthalmic veins (superior and inferior), with their tributaries.

Nerves, . . {
- Oculo-motor (3rd cerebral).
- Trochlear (4th cerebral).
- Abducent (6th cerebral).
- Frontal, Lacrimal, Naso-ciliary, } from ophthalmic division of the trigeminal or fifth cerebral nerve.
- Zygomatic branch of the maxillary division of the trigeminal nerve.

Ciliary ganglion.
Lacrimal gland.
Fascia Bulbi.

Dissection.—The roof of the orbit must be removed with the aid of the saw, the chisel, and the bone forceps. Begin by

PLATE VIII

FIG. 89.—Antero-posterior radiograph of Living Skull. (Gouldesbrough.)

PLATE IX

FIG. 90.—Antero-posterior radiograph of Skull, showing large frontal sinuses.

removing the thick cranial wall above the orbital opening, leaving only a thin portion corresponding to the superior orbital arch.

Strip the soft structures including the periosteum downwards from the cut margin of the skull to the superior orbital margin. Then take the saw and make two incisions through the frontal bone to the floor of the anterior fossa. One, vertically downwards, opposite the anterior end of the cribriform plate of the ethmoid, and the second downwards and forwards immediately anterior to the lateral end of the small wing of the sphenoid. After the saw cuts are made take the bone forceps and chip away the frontal bone between the saw cuts, to the level of the floor of the anterior fossa. As the bone is removed the frontal air sinus may be opened and its extent should be noted (Figs. 89, 90). Next take the chisel and cut through the floor of the anterior fossa immediately in front of the posterior border of the small wing of the sphenoid. Carry the cut medially to 2 mm. in front of the optic foramen; then turn it forwards along the medial border of the orbital plate of the frontal bone and lateral to the depression in the region of the cribriform plate of the ethmoid; then, with the aid of the chisel and bone forceps, gradually chip away the whole of the bony roof of the orbit, but do not injure the subjacent periosteum. Next remove the remains of the small wing of the sphenoid with the exception of the margin of the optic foramen, which must be left intact. The superior orbital fissure is now fully opened up, and no difficulty will be met with as the nerves in the wall of the cavernous sinus are traced forwards into the orbit, but the anterior clinoid process may be chipped away to gain additional freedom for further dissection. After the bony roof of the orbit has been removed examine the exposed periosteum.

Periosteum. — If the dissection has been successfully carried out, the periosteum clothing the under surface of the orbital roof will be exposed uninjured. The periosteum of the orbit forms a funnel-shaped sheath, which encloses all the contents of the cavity except the zygomatic and infra-orbital nerves and the infra-orbital artery. It is but loosely attached to its bony walls. Posteriorly, it is directly continuous, through the superior orbital fissure, with the dura mater. Expanding with the cavity, it becomes continuous anteriorly, around the orbital opening, with the periosteum which clothes the exterior of the skull. There it presents important connections with the palpebral fascia also.

Dissection.—Open the eyelids and draw the eyeball forwards with the forceps; then, with a fine needle, carry a piece of thread through the ocular conjunctiva, being careful not to penetrate the eyeball, for that would render its subsequent inflation impossible. Finally, stitch the thread to the nose, and the eyeball will be securely held forwards. Turn now to the periosteum of the roof of the orbit, divide it transversely, close to the anterior margin of the orbit, and then, from before backwards, along the middle line of the orbit. Turn the two flaps so marked out laterally and medially respectively. As the region of the superior orbital fissure is approached be careful not to injure the nerves which pass through the fissure; the one most likely to be injured is the small trochlear nerve which lies near the medial end of the fissure. Secure it at once, and trace it forwards through the fat to the superior oblique muscle which lies along the upper part of the medial wall of the

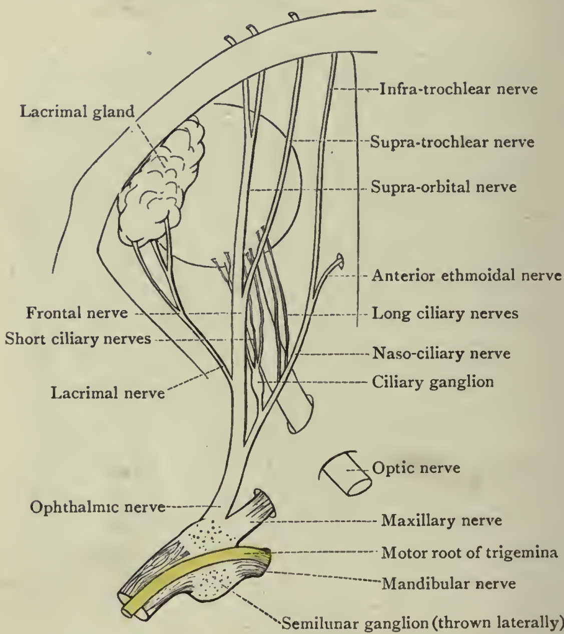


FIG. 91.—The Ophthalmic Nerve of the Left Side. The semilunar ganglion and the nerves have been everted and turned over to show the motor root.

orbit. In the middle line of the orbit the large frontal nerve will be found lying in the fat on the surface of the levator palpebræ superioris. Trace the nerve forwards to its division into its two terminal branches :—a large supra-orbital branch accompanied by a corresponding artery, and a medial and smaller supra-trochlear branch. Follow the supra-trochlear branch to the superior medial angle of the orbit, where it passes above the pulley of the superior oblique muscle. Return to the trochlear nerve and the superior oblique muscle; clean the muscle from behind forwards. It ends in a tendon which passes through the fibrous pulley, situated at the upper and medial angle of the orbit, then turns backwards and laterally. and disappears below the levator palpebræ superioris and the superior rectus. Define both the tendon and the pulley. Return to the frontal nerve, pull it aside and clean the levator palpebræ superioris, upon which the nerve lies. Define the margins of the levator palpebræ and note that it lies upon the superior rectus muscle of the eyeball. Raise the levator palpebræ, carefully, and note a small twig of the superior division of the ocular motor nerve which pierces the superior rectus and enters the levator palpebræ. Now find the lacrimal nerve and the accompanying lacrimal artery, which lie in the fat at the junction of the roof with the lateral wall of the orbit, and trace them forwards to the lacrimal gland. The gland lies under cover of the lateral end of the superior orbital margin. When all the structures which have been mentioned have been found and cleaned study them in detail.

Nervus Frontalis.—The frontal nerve is the continuation of the stem of the ophthalmic division of the trigeminal nerve, after it has given off its lacrimal and naso-ciliary branches. It enters the orbit through the superior orbital fissure, above the muscles, and runs forwards, upon the upper surface of the levator palpebræ superioris, immediately subjacent to the periosteal lining of the orbital cavity. It ends, at a variable distance from the orbital opening, by dividing into the supra-orbital and supra-trochlear branches.

The *supra-trochlear nerve* is the medial and smaller of the two terminal branches of the frontal. It runs towards the trochlea of the superior oblique muscle, above which it pierces the palpebral fascia, leaves the orbit, and turns round the orbital arch to reach the forehead. Its further course has been described already (p. 47). In the orbit it gives off one small twig close to the pulley of the superior oblique muscle; the twig passes downwards to join the infra-trochlear branch of the naso-ciliary nerve.

The *supra-orbital nerve* is continued onwards, in the line of the parent stem, and, passing through the supra-orbital notch or foramen, it turns upwards on the forehead (p. 47). The division of the supra-orbital nerve into a lateral and a medial branch was seen during the dissection of the scalp (p. 47). Sometimes the separation takes place within the orbit, and in that case the larger *lateral* part occupies the supra-orbital notch.

Nervus Lacrimalis.—The lacrimal nerve is the smallest of the terminal branches of the ophthalmic division of the trigeminal. It enters the orbit through the superior orbital fissure, above the level of the muscles, and runs forwards,

PLATE X

FIG. 92.—Dissection of the Orbit and the Middle Fossa of the Cranium. On the right side the trochlear nerve has been removed, and in the left orbit portions of the structures above the ophthalmic artery have been taken away. (Dr. E. B. Jamieson.)

1. Superior sagittal sinus.
2. Cut anterior part of falx cerebri.
3. Muco-periosteum of anterior ethmoidal air cell.
4. Anterior ethmoidal artery and nerve and posterior ethmoidal artery.
5. Muco-periosteum of a middle ethmoidal air cell.
6. Muco-periosteum of a posterior ethmoidal air cell.
7. Optic nerve.
8. Ophthalmic artery.
9. Internal carotid artery.
10. Wall of right cavernous sinus.
11. Oculo-motor nerve.
12. Basilar plexus.
13. Abducens nerve.
14. Inferior petrosal sinus.
15. Semilunar ganglion.
16. Middle meningeal artery.
17. Mandibular nerve.
18. Maxillary nerve.
19. Oculo-motor nerve.
20. Trochlear nerve.
21. Frontal nerve.
22. Superior ophthalmic vein.
23. Orbital branch of middle meningeal artery.
24. Posterior ciliary arteries and short ciliary nerves.
25. Lacrimal artery and nerve.
26. Superior rectus.
27. Levator palpebræ superioris.
28. Supra-orbital nerve.
29. Supra-trochlear nerve.
30. Supra-orbital artery.
31. Terminal part of ophthalmic artery.
32. Muco-periosteum of infundibulum.

PLATE X

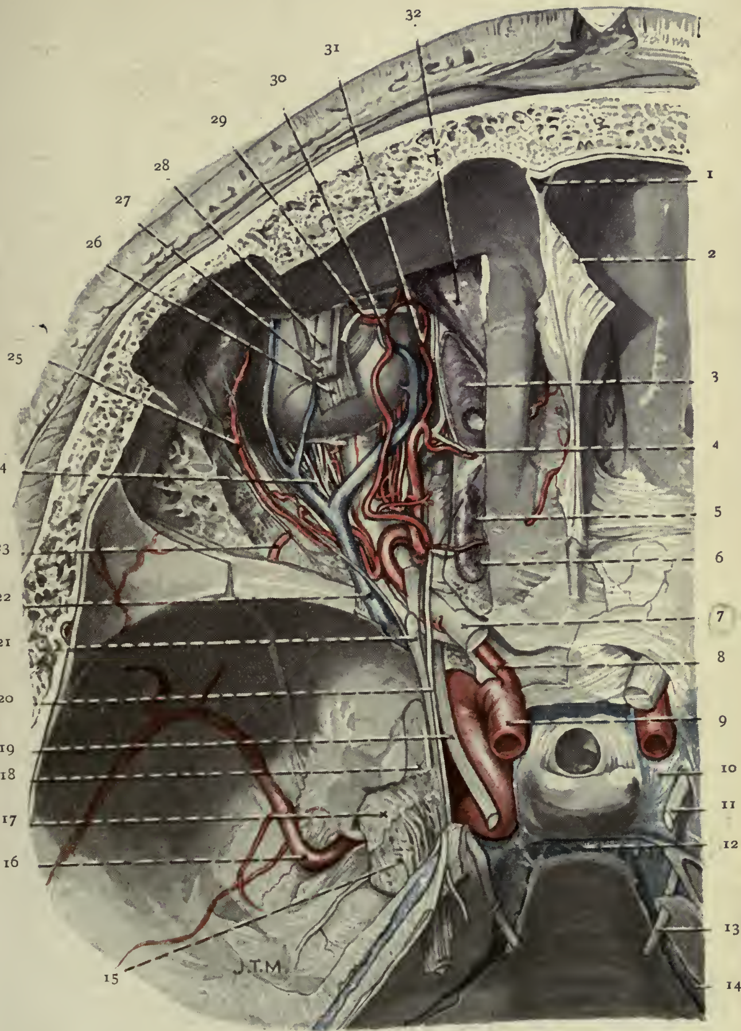


FIG. 92.

along the lateral wall of the cavity, above the upper margin of the lateral rectus muscle. At the anterior part of the orbit it continues its course, under cover of the lacrimal gland, until it reaches the lateral part of the upper eyelid, in which it ends (p. 27). Within the orbital cavity it gives numerous twigs to the deep surface of the lacrimal gland, and sends downwards a filament which connects it with the zygomatic branch of the maxillary nerve.

Nervus Trochlearis.—The small trochlear nerve is destined entirely for the supply of the superior oblique muscle. Having entered the orbit through the superior orbital fissure, above the muscles, it passes forwards and medially, under the periosteum, and finally sinks into the posterior part of the upper or orbital surface of the superior oblique muscle.

Glandula Lacrimalis.—The lacrimal gland is a small, flattened and distinctly lobular structure, of oval form, which is placed in the antero-lateral part of the orbit, its long axis lying parallel with the anterior margin of the orbit (Figs. 92, 97). It consists of two parts or groups of lobules—a superior and an inferior—imperfectly separated from each other. The *glandula lacrimalis superior*, which constitutes the main mass of the gland, lies in the orbital cavity. Its lateral convex surface is lodged in a hollow upon the medial aspect of the zygomatic process of the frontal bone, and it is bound to the lateral part of the orbital arch by short fibrous bands which proceed from the periosteum. The deep or medial surface is slightly concave, and rests upon the levator palpebræ superioris and lateral rectus, which intervene between it and the eyeball. The *glandula lacrimalis inferior* lies below and anterior to the superior part, from which it is partially separated by the expanded tendon of the levator palpebræ superioris. It projects into the base of the upper eyelid, and rests upon the conjunctiva which lines the deep aspect of the lid. That portion of the gland has been already examined in the dissection of the eyelids (p. 27). Even in the undissected subject it can be seen, through the conjunctiva, when the upper eyelid is fully everted.

The lacrimal gland secretes the tears, and its ducts (three to five from the superior part and three to nine from the inferior part) open upon the deep surface of the upper eyelid in the neighbourhood of the fornix (Fig. 9).

Musculus Levator Palpebræ Superioris.—The elevator muscle of the upper eyelid rests upon the upper surface of the rectus superior. Posteriorly, it is narrow and pointed, but it expands as it passes forwards, above the eyeball, to the upper eyelid. It arises from the under surface of the roof of the orbit, immediately anterior to the optic foramen and, therefore, from the inferior surface of the small wing of the sphenoid bone. In the anterior part of the orbital cavity it widens out into a broad membranous expansion, which splits into three lamellæ. The most anterior lamella is attached to the palpebral fascia of the upper eyelid and by it to the upper tarsus. The middle lamella is attached directly to the upper border of the upper tarsus. The posterior lamella is attached to the upper margin of the conjunctiva. The lateral and medial margins of the expansion are fixed to the rim of the orbital opening, in close proximity to the medial palpebral ligament and the lateral palpebræ raphe. By those attachments, excessive action of the muscle upon the upper eyelid is checked. The levator palpebræ superioris is supplied by the upper division of the oculo-motor nerve, and it is the elevator not only of the upper eyelid but also of the upper fornix of the conjunctiva.

Dissection.—Divide the frontal nerve and throw the ends forwards and backwards. The levator palpebræ superioris also may be cut midway between its origin and insertion. When the posterior portion is raised a minute nerve twig will be seen entering its deep or ocular surface ; it is a branch of the superior division of the third or oculo-motor nerve.

The eyeball should now be inflated. That may be done from the front or from behind. If the latter method is selected, gently separate the fat under cover of the superior rectus muscle, and push the ciliary vessels and nerves away from the optic nerve. Next, make a small incision through the sheath of the nerve. Pass a ligature round the nerve, anterior to the opening, and then pass a blowpipe, provided with a stylet, through the incision and along the nerve, into the interior of the eyeball. When the globe of the eye is fully inflated, the ligature may be tightened as the blowpipe is withdrawn. A very much better plan, however, is to inflate the eyeball from the front. For that purpose make an oblique valvular aperture in the sclero-corneal junction, with the point of a sharp narrow-bladed knife. Insert a blowpipe through the aperture, and on its withdrawal, after the inflation of the eyeball, the valvular character of the opening is sufficient to prevent the escape of the air.

Posterior to the eyeball, at the sides of the superior rectus, the dissector will notice a quantity of loose bursal-like tissue. It is the *fascia bulbi* (O.T. *capsule of Tenon*). Seize the upper part of it with the forceps, and remove a small portion with a pair of scissors. An aperture is thus made in the fascia, and the handle of the knife can be introduced into the space between it and the eyeball. In favourable cases the extent of the fascia can be gauged, and perhaps even the prolongations or sheaths which it gives to the tendons of the ocular muscles may be made out. The description of the fascia bulbi is given on p. 259.

Musculus Rectus Superior.—The superior rectus, which lies under cover of the levator palpebræ superioris, is now fully exposed. It is the thinnest of the recti muscles, and it arises from the upper margin of the optic foramen, passes forwards above the optic nerve, and ends, upon the upper aspect of the eyeball, in a thin, delicate and somewhat expanded tendon, which is inserted into the sclera, about 8 mm. posterior to the sclero-corneal junction. It is supplied by a branch from the *superior division* of the *oculomotor nerve*; when it contracts it turns the eyeball so that the centre of the cornea moves upwards and medially.

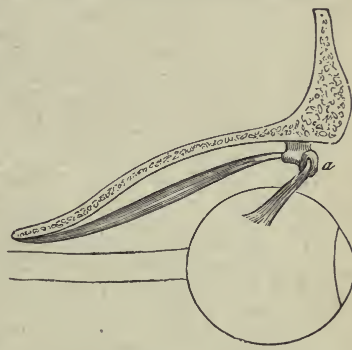


FIG. 93.—Diagram of the Superior Oblique Muscle. (From Hermann Meyer.)

a. Trochlea and synovial sheath.

Musculus Obliquus Superior.—The superior oblique muscle is the longest and narrowest of the muscles attached to the eyeball. It arises from the roof of the orbit, immediately anterior to the upper and medial part of the optic foramen between the rectus superior and the rectus medialis. It passes forwards along the upper part of the medial wall of the cavity, above the medial rectus. At the anterior part of the orbit it ends in a slender tendon, which enters the *trochlea* and at once changes its direction, proceeding backwards and laterally, upon the upper surface of the eyeball, under cover of the superior rectus. Beyond the lateral edge of the superior rectus the tendon expands somewhat, and is inserted into the sclera, midway between the entrance of the optic nerve and the cornea (Fig. 93).

The *trochlea* or *pulley* through which the tendon passes is a small fibro-cartilaginous ring, which is attached by fibrous tissue to the trochlear fossa of the frontal bone. The pulley is lined with a synovial sheath which facilitates the movement of the tendon; and from its lateral margin it gives a fibrous investment to the tendon.

The superior oblique is supplied by the trochlear nerve and moves the eyeball so that the centre of the cornea is turned downwards and laterally.

Dissection.—Divide the superior rectus midway between its origin and its insertion, and reflect the cut ends. When the posterior part of the muscle is raised, the superior division of the oculo-motor nerve is brought into view, as it sinks into the deep or ocular surface of the muscle. It sends a twig to the levator palpebræ superioris. The removal of some fat will bring the optic nerve more fully into view. At the posterior part of the orbit three structures will be seen crossing the optic nerve—viz., (1) the naso-ciliary nerve; (2) the ophthalmic artery; and (3) the superior ophthalmic vein. All three must be carefully cleaned and their branches followed out. From the naso-ciliary nerve one or two delicate thread-like branches—the *long ciliary nerves*—will be found passing along the optic nerve to reach the eyeball. The *short ciliary nerves*, much more numerous, accompany the long ciliary branches, and can readily be disengaged from the fat which surrounds the optic nerve. A strong member of the short ciliary group should be selected and followed backwards; it will lead the dissector to the *ciliary ganglion*. That is a minute body which is situated upon the lateral side of the optic nerve in the posterior part of the orbit. With a little patience and care the roots which the naso-ciliary nerve and inferior division of the oculo-motor nerve give to the ciliary ganglion can be isolated, and perhaps even the sympathetic root from the internal carotid plexus will be found. After the ciliary ganglion and its roots and branches have been defined, clear away the fat which lies lateral to the ganglion, and secure the abducens nerve, which enters the ocular surface of the lateral rectus. Then clean the optic nerve (Fig. 92).

Nervus Opticus.—The optic nerve enters the orbit through the optic foramen. It carries with it a strong, loose sheath of dura mater, and also more delicate investments from the arachnoid and pia mater. The ophthalmic artery, which accompanies it, lies on its infero-lateral aspect. Within the orbit the nerve inclines forwards and laterally, and at the same time somewhat downwards, to the back of the eyeball, where it pierces the sclera a short distance to the medial side of the centre of its posterior surface. The dissector has noted already that the ophthalmic artery and vein and the naso-ciliary nerve cross above the optic nerve, and that it is closely accompanied by the delicate ciliary nerves and vessels. The optic nerve is slightly longer than the distance which it has to run from the optic foramen to the globe of the eye, so that the movements of the eyeball may not be interfered with. Within the eyeball the optic nerve spreads out in the retina.

Nervus Naso-ciliaris.—The naso-ciliary nerve (O.T. nasal) arises from the ophthalmic division of the trigeminal in the anterior part of the cavernous sinus. It passes through the superior orbital fissure and enters the orbital cavity, between the two heads of the lateral rectus muscle and between the two divisions of the third nerve. It then runs forwards and medially, and, crossing obliquely above the optic nerve, it runs between the medial rectus and superior oblique muscles to the medial wall of the orbit, where it divides into two terminal branches — viz., the infra-trochlear and the anterior ethmoidal nerves. In addition to those, it gives off in the orbit the following branches: (1) long root to the ciliary ganglion; (2) long ciliary nerves; (3) posterior ethmoidal nerve.

Radix Longa Ganglii Ciliaris.—The long root of the ciliary ganglion is a very slender filament which springs from the naso-ciliary as it enters the orbit between the heads of the lateral rectus. It runs along the lateral side of the optic nerve, and enters the upper and posterior part of the ciliary ganglion.

Nervi Ciliares Longi.—The two long ciliary branches spring from the naso-ciliary as it crosses the optic nerve. They pass forwards, upon the medial side of the optic nerve, to reach the globe of the eye, where they pierce the sclera. One of the long ciliary nerves very constantly unites with one of the short ciliary filaments.

Nervus Ethmoidalis Posterior.—The posterior ethmoidal nerve passes through the posterior ethmoidal foramen to the ethmoidal cells and the sphenoidal air sinus.

Nervus Infratrochlearis.—The infra-trochlear branch runs along the medial wall of the orbit below the superior oblique muscle. After passing under the trochlea of that muscle, it emerges from the orbit and appears upon the face above the medial commissure of the eyelids, where it has been dissected already (p. 27). Near the pulley it receives a communicating twig from the supra-trochlear nerve.

Nervus Ethmoidalis Anterior.—The anterior ethmoidal nerve is the larger of the two terminal branches of the naso-ciliary nerve. It leaves the orbit by the anterior ethmoidal canal, and is conducted to the interior of the cranium, in which it appears at the lateral margin of the cribriform plate of the ethmoid. The canal in which it runs can readily be opened up with the bone-forceps to expose the nerve. Upon the cribriform plate it turns forwards, under the dura mater, and almost immediately disappears, through a slit-like aperture at the side of the crista galli, into the nasal cavity. There it gives *internal nasal branches* to the mucous membrane, and is continued downwards upon the posterior aspect of the nasal bone. Finally, it emerges upon the face, as the *external nasal nerve*, by passing between the lower margin of the nasal bone and the lateral cartilage of the nose. Its terminal filaments have been described already (p. 30).

Ganglion Ciliare (Fig. 97).—The ciliary ganglion is a small quadrangular body, not much larger than the head of a large pin. It is placed in the posterior part of the orbit, between the optic nerve and the lateral rectus muscle, and very commonly on the lateral side of the ophthalmic artery. At its posterior border it receives its three roots; whilst from its anterior border the short ciliary nerves are given off.

The *sensory root* is given off by the naso-ciliary, and is called the *long root.* The *short* or *motor root* is a short, stout trunk; it springs from the branch of the oculo-motor nerve which goes to the inferior oblique muscle. The *sympathetic root* is derived from the internal carotid plexus; it joins the ganglion, close to the entrance of the long root from the naso-ciliary nerve. In some cases it joins the long root before it reaches the ganglion.

Nervi Ciliares Breves.—The short ciliary nerves are from five to seven in number. As they pass along the optic nerve they divide and thus increase in number; at the back of the eyeball from twelve to eighteen may be counted. They form two groups, superior and inferior, and the lower nerves are generally more numerous than the upper. Finally, they pierce the sclera by a series of apertures which are placed around the entrance of the optic nerve.

Arteria Ophthalmica.—The ophthalmic artery is a branch of the internal carotid. It accompanies the optic nerve into the orbit through the optic foramen. At first it lies below the optic nerve, but soon winds round its lateral side, and, crossing above it, passes forwards along the medial wall of the orbit, below the superior oblique muscle. At the medial margin of the front of the orbit it ends by dividing into two terminal branches—viz., the frontal and the dorsal nasal (Fig. 95).

The *branches* of the ophthalmic artery are very numerous, but it is seldom that they can all be satisfactorily displayed, unless a special injection has been made. They are :—

1. Lacrimal.	4. Ciliary.	7. Palpebral.
2. Muscular.	5. Supra-orbital.	8. Dorsal nasal.
3. Arteria centralis retinæ.	6. Ethmoidal.	9. Frontal.

Arteria Lacrimalis.—The lacrimal branch accompanies the lacrimal nerve; it supplies the lacrimal gland and the

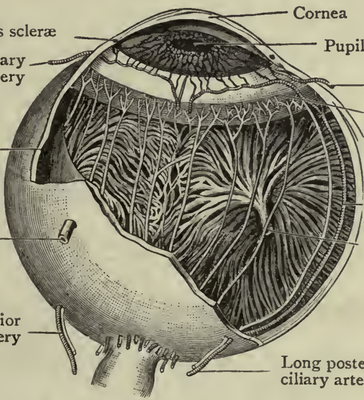


FIG. 94.—Dissection of the Eyeball showing the Arrangement of the Ciliary Nerves and Vessels.

conjunctiva. In each eyelid an arterial arch, the *arcus tarseus*, is formed by the anastomoses of the two lateral palpebral branches of the lacrimal with the two medial palpebral branches of the ophthalmic.

Muscular branches come off at variable points, not only from the main artery, but also from certain of its branches. They supply the muscles contained in the orbital cavity.

Arteria Centralis Retinæ.—The arteria centralis retinæ is a minute but important artery. It pierces the infero-medial surface of the optic nerve, 12 mm. (about half an inch) posterior to the eyeball, and passes, in the substance of the nerve, to the interior of the globe of the eye.

Arteriæ Ciliares.—The ciliary arteries are very numerous. Two groups are recognised—viz., a posterior and an anterior. Two sets of posterior ciliary arteries are described. They are known as the short and the long posterior ciliary arteries respectively. The *short ciliary arteries* are several in number; they spring partly from the ophthalmic trunk and partly from its lacrimal and muscular branches. They accompany the short ciliary nerves and, after piercing the posterior part of

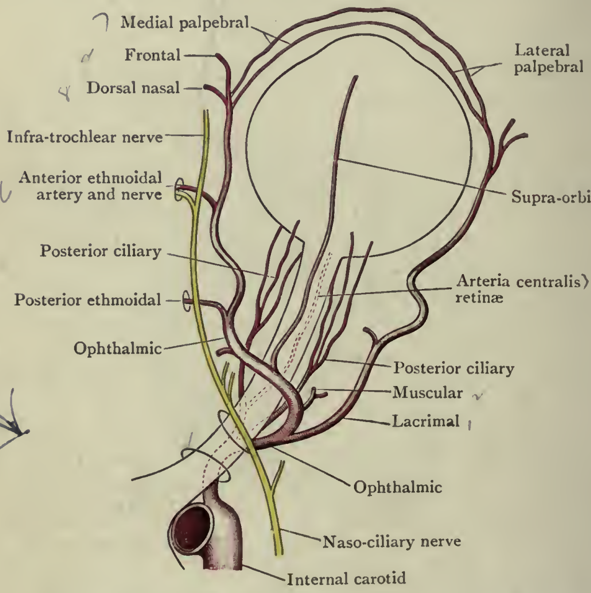


FIG. 95.—Diagram of the Ophthalmic Artery and its Branches. (After Quain and Meyer, modified.)

the sclera, around the optic nerve, they enter the chorio-capillary layer of the chorioid. The *long posterior ciliary arteries* (Fig. 94) are two in number. They spring from the ophthalmic trunk and run forwards, one on each side of the optic nerve. After they have pierced the sclera they run forward, one on each side, in the horizontal plane, and between the sclera and the chorioid to the iris. The *anterior ciliary arteries* come off, in the anterior part of the orbit, from the lacrimal and muscular branches. They vary in number from six to eight, and run to the anterior part of the eyeball, where they form an arterial circle under the conjunctiva. Finally, they pierce the sclera immediately posterior to the cornea.

Arteria Supraorbitalis.—The supra-orbital artery accompanies the supra-orbital nerve to the forehead, where it was dissected at a previous stage (p. 47).

Arteriæ Ethmoidales.—There are two ethmoidal branches, an anterior and a posterior; they pass through the anterior and posterior ethmoidal foramina in the medial wall of the orbit. The *posterior ethmoidal artery* supplies the mucous lining of the posterior ethmoidal cells, and sends twigs to the upper part of the nose. The *anterior ethmoidal artery* is a larger branch. It runs in company with the anterior ethmoidal nerve, and gives off minute twigs at each stage of its course. Thus, in the anterior ethmoidal foramen, it gives branches to the mucous lining of the anterior ethmoidal cells and the frontal sinus; during its short sojourn in the cranial cavity it gives off a small *anterior meningeal artery*; in the nasal cavity, it gives twigs to the mucous membrane. Its terminal branch appears on the face and supplies the side of the nose.

Arteria Dorsalis Nasi.—The dorsal artery of the nose is distributed at the root of the nose, and anastomoses with the angular branch of the external maxillary artery.

Arteria Frontalis.—The frontal artery accompanies the supra-trochlear nerve to the forehead, where it has been dissected already (p. 47).

Venæ Ophthalmicæ.—As a general rule there are two ophthalmic veins, superior and inferior. The *superior ophthalmic vein* is the larger of the two and it accompanies the artery. It takes origin at the root of the nose, where it communicates with the angular vein. The *inferior ophthalmic vein* lies below the level of the optic nerve, and it is brought into communication with the pterygoid venous plexus by an offset which passes through the inferior orbital fissure. The two ophthalmic veins receive numerous tributaries during their course through the orbit; finally they pass between the two heads of the lateral rectus muscle, and through the superior orbital fissure, to open into the cavernous sinus, either separately or by a common trunk.

Musculi Recti et Obliqui Oculi.—Associated with the origins of the recti muscles of the eyeball are two tendinous arches, a superior and an inferior. Both are attached laterally to a projection on the great wing of the sphenoid bone at the lateral margin of the superior orbital fissure. The two bands diverge from one another as they pass medially across the superior orbital fissure, the upper band extending to the superior margin, and the lower to the inferior margin of the optic foramen. The superior rectus, which is the thinnest of the four recti, springs from the medial part of the upper band; the inferior rectus, which is thicker but smaller than the superior, springs from the middle part of the lower band. The lateral and longest rectus, which is thicker than either the superior or inferior, arises by two heads, one from the lateral part of the upper band, and one from the lateral part of the lower band. The interval between the two heads is traversed by the two divisions of the oculo-motor nerve, the naso-ciliary nerve, the abducens nerve, and the ophthalmic veins. The medial rectus, which is the shortest and thickest of all the recti, springs from the medial part of the lower band. The superior oblique springs from the body of the sphenoid, between the superior and medial recti. The origin of the inferior oblique lies near the anterior margin of the orbital cavity, entirely away from the other muscles which move the eyeball. It arises from the orbital plate of the maxilla close to the lower and medial angle of the orbital cavity.

Dissection.—To display the attachments of the ocular muscles which arise at the apex of the orbital cavity divide the optic nerve close to the optic foramen, and turn the eyeball forwards. Then define the origin of each muscle, but take care not to injure the structures which pass between the upper and lower heads of the lateral rectus. Next, replace the eyeball in position and display the inferior oblique which lies in the anterior part of the orbital cavity and is best dissected from the front. Evert the lower eyelid and make an incision through the conjunctiva, along the level of its reflection from the eyelid to the eyeball. A little dissection in the floor of the anterior part of the orbit and the removal of some fat will expose the inferior oblique muscle, as it passes laterally and backwards to gain the lateral surface of the sclera.

After the origins of the muscles have been satisfactorily displayed study first the arrangement of the nerves which pass through the superior orbital fissure, next the insertions of the muscles which move the eyeball, and finally the remaining structures which lie in the orbital cavity.

Arrangement of the Nerves in the Superior Orbital Fissure.—The various nerves met with in the dissection of the cavernous sinus can now be traced into the orbital cavity, and the dissector will note that the arrangement of the nerves in the superior orbital fissure is somewhat different from that in the sinus.

The lacrimal, frontal, and trochlear nerves enter the orbit above the upper head of the lateral rectus muscle, on very much the same plane (Fig. 96). The other nerves enter between the heads of the lateral rectus—the superior division of the oculo-motor nerve occupying the highest place; next comes the naso-ciliary nerve; then the inferior division of the oculo-motor nerve; and the abducent nerve is the lowest.

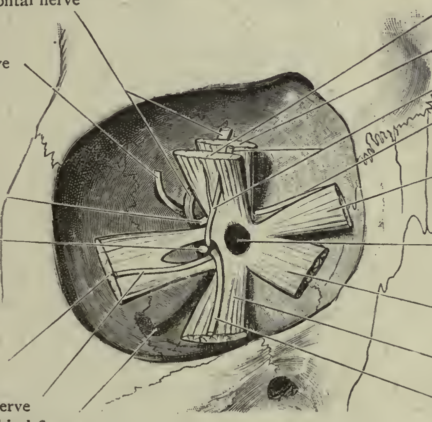


FIG. 96.—Diagram of the Orbital Cavity, and of the origin of the ocular muscles in relation to the optic foramen and the superior orbital fissure, and the nerves that traverse the fissure.

Insertions of the Muscles which move the Eyeball.—The recti are inserted into the sclera, 6 to 8 mm. (about quarter of an inch) behind the cornea. The medial rectus has the most anterior insertion, and both the medial and lateral recti are attached a little further forwards than the superior and inferior recti. The insertions of the superior and inferior oblique muscles are both much further back than the insertions of the recti, behind the transverse vertical plane which divides the eyeball into equal anterior and posterior parts, and mainly lateral to an antero-posterior vertical plane which divides the eyeball into equal lateral and medial halves.

Nervus Oculomotorius.—The two divisions of the oculomotor nerve enter the orbit through the superior orbital fissure, between the two heads of the lateral rectus. The *superior division* has been traced to the rectus superior and the levator palpebræ superioris. The *inferior division* is larger. It almost immediately divides into three branches,

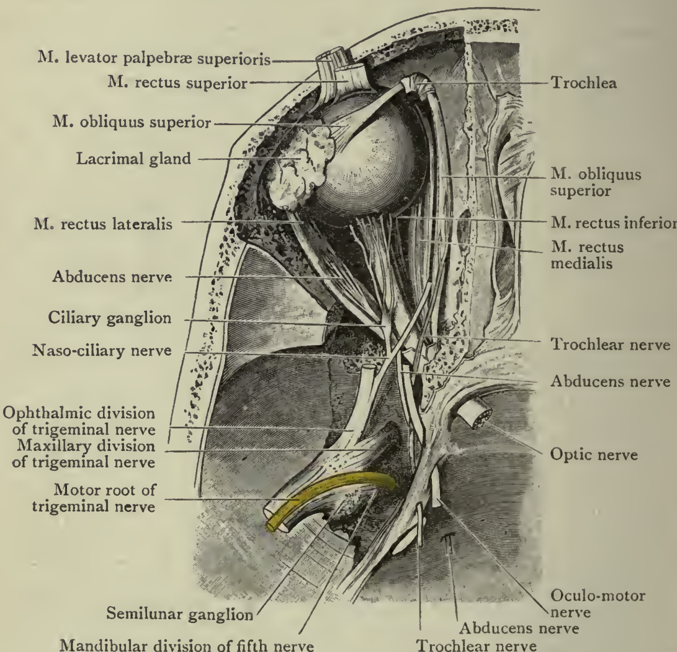


FIG. 97.—Dissection of the Orbit and the Middle Cranial Fossa. Both roots of the fifth nerve, with the semilunar ganglion, are turned laterally.

for the supply of the rectus medialis, the rectus inferior, and the obliquus inferior. The nerves to the two recti enter the ocular surfaces of the muscles; the nerve to the inferior oblique is prolonged forwards, in the interval between the rectus inferior and rectus lateralis, and enters the posterior border of the inferior oblique muscle. Soon after its origin this branch gives the *short motor root* to the ciliary ganglion.

Nervus Abducens.—The abducens nerve will be found closely applied to the ocular surface of the lateral rectus. It enters the orbit through the interval between the heads of lateral rectus muscle, and it supplies the lateral rectus only.

Musculus Obliquus Inferior.—The inferior oblique muscle arises from a small depression on the orbital surface of the maxilla, immediately lateral to the opening of the naso-lacrimal duct. It passes laterally, below the inferior rectus muscle, and, inclining slightly backwards, ends in a thin membranous tendon, which gains insertion into the lateral aspect of the sclera of the eyeball under cover of the rectus lateralis. The insertion is not far from that of the superior oblique. The inferior oblique is supplied by the *inferior division* of the *oculo-motor nerve*. It turns the eyeball so that the centre of the cornea is directed upwards and laterally.

Fascia Bulbi (O.T. **Capsule of Tenon**).—The connections of the fibrous sheath of the eyeball are somewhat complicated, and they cannot be satisfactorily displayed, in every detail, in an ordinary dissection. The fascia may be studied from a threefold point of view—(1) in its connection with the eyeball; (2) in its connections with the muscles inserted into the globe of the eye; and (3) in its connections with the walls of the orbit.

The relation which the fascia bulbi bears to the eyeball is very simple. The membrane is spread over the posterior five-sixths of the globe—the cornea alone being free from it. *Anteriorly*, it lies in relation with the ocular conjunctiva, with which it is intimately connected, and it ends by blending with the conjunctiva close to the margin of the cornea. *Posteriorly*, it fuses with the sheath of the optic nerve where the nerve pierces the sclera. The internal surface of the membrane (*i.e.* the surface towards the globe of the eye) is smooth, and is connected to the eyeball by some soft, yielding, and humid areolar tissue, the interval between them constituting, in fact, an extensive lymph space. Its external surface is in contact posteriorly with the orbital fat, to which it is loosely adherent; and it is firmly attached to the ocular conjunctiva more anteriorly. It obviously, therefore, forms a membranous socket in which the eyeball can rotate with the greatest freedom.

The tendons of the various ocular muscles are inserted into the eyeball within the fascia bulbi, and they gain its interior by piercing the fascia opposite the equator of the globe (Fig. 98). The lips of the openings through which the four recti muscles pass are prolonged backwards upon the muscles, in the form of sheaths, much in the same manner that the internal spermatic fascia is prolonged upon the spermatic cord from the abdominal inguinal ring. The sheaths gradually become more and more attenuated, until at last they blend with the perimysium of the muscular bellies. In the case of the superior oblique muscle the corresponding prolongation is related only to the reflected portion of the tendon; and it ends by becoming attached to the fibrous pulley through which the tendon passes. The sheath of the inferior oblique may be traced upon the muscle as far as the floor of the orbit. The ocular edge of each of the four apertures through which the recti muscles pass is strengthened by a slip of fibrous tissue (Lockwood), and as the fascia bulbi is firmly bound to the bony wall of the orbit at various points these slips act as pulleys, and protect the globe of the eye from pressure during contraction of the muscles. The aperture for the superior oblique is not furnished with such a slip, and it is doubtful if the opening for the inferior oblique muscle possesses one.

Dissection.—An admirable view of the relations which the fascia bulbi presents to the eyeball and the tendons of the ocular muscles can be obtained by the following dissection:—Divide the lateral commissure of the eyelid up to the margin of the orbital opening. Pull the eyelids widely apart, so as to expose as much as possible of the anterior face of the eyeball. Next, divide the conjunctiva, by a circular incision, just beyond the cornea. Along that line the fascia bulbi is so intimately connected with the conjunctiva that it is divided at the same time. Now raise carefully both conjunctiva and fascia bulbi from the surface of the eyeball, and spread them out round the orbital opening, as is depicted in Fig. 98. The openings in the fascia bulbi for the tendons of the ocular muscles and the thickened margins of the apertures are well seen. Note also the sheaths which are given to the muscles.

Check and Suspensory Ligaments.—The connections of the fascia bulbi to the walls of the orbital cavity are somewhat complicated. The *suspensory ligament* (Lockwood) plays an important part in supporting the eyeball. It stretches across the anterior part of the orbit, after the fashion of a hammock; its two extremities are narrow, and are attached respectively to the zygomatic and lacrimal bones. Below the eyeball it widens out and blends with the fascia bulbi. The *lateral* and *medial check ligaments* also constitute bonds of union between the fascia bulbi and the orbital wall. They are strong bands which pass from the sheaths around the lateral and medial recti muscles to obtain attachment to the zygomatic and lacrimal bones respectively, where they are brought into association with the extremities of the suspensory ligament. The function of the check ligaments is to limit the contraction of the medial and lateral recti muscles, and thus prevent excessive rotation of the eyeball in a lateral or medial direction. There is a similar but less direct provision by means of which the actions of the superior and inferior recti muscles are limited.

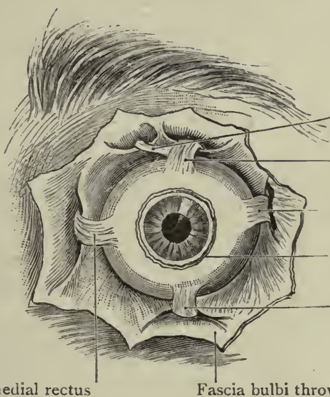


FIG. 98.—Dissection of the Fascia Bulbi from the front.

The action of the superior rectus is checked through an intimate connection with the levator palpebræ superioris in the anterior part of the orbit; the action of the inferior rectus is checked through a connection with the suspensory ligament.

> ***Dissection.***—In order that the zygomatic branch of the maxillary division of the trigeminal nerve may be displayed in its course through the orbit, the orbital contents must be removed. The nerve will then be found in the midst of a little soft fat in the angle between the floor and lateral wall of the orbit.

Nervus Zygomaticus (O.T. **Temporo-Malar**).—The zygomatic nerve is small. It arises, in the infra-temporal fossa, from the maxillary division of the trigeminal nerve. It enters the orbit through the inferior orbital fissure, and almost immediately divides into two terminal branches — the zygomatico-temporal and the zygomatico-facial.

Ramus Zygomaticotemporalis. — The zygomatico-temporal branch runs forwards and upwards upon the lateral wall of the orbit, under cover of the periosteum, and, after receiving a communicating twig from the lacrimal nerve, it enters the zygomatico-orbital canal of the zygomatic bone. That canal conducts it to the anterior part of the temporal region, where it has been examined already (pp. 19 and 170).

Ramus Zygomaticofacialis.—The zygomatico-facial branch also enters a zygomatico-orbital canal, and is finally conducted to the face by the zygomatico-facial canal which traverses the zygomatic bone (p. 19).

PREVERTEBRAL REGION.

The following are the structures to be displayed in the prevertebral area :—

Prevertebral muscles.	Vertebral vein.
Intertransverse muscles.	Vertebral and cranio-vertebral articulations.
Cervical nerves.	
Vertebral artery.	

Dissection.—To separate the anterior part of the head, with the pharynx, from the posterior part and the vertebral column a somewhat complicated dissection is necessary. Place the head upside down, so that the cut margin of the skull rests upon the table ; divide the common carotid artery, the internal jugular vein, the vagus nerve, and the sympathetic trunk, on each side, at the level of the neck of the first rib ; pull the trachea and œsophagus, together with the great blood-vessels and nerves, away from the anterior surface of the vertebral column. The separation must be effected right up to the base of the skull. At that point great caution must be observed ; otherwise, the pharyngeal wall or the insertions of the prevertebral muscles will be damaged. The base of the skull having been reached, the point of the knife should be carried across the basilar portion of the occipital bone, between the pharynx and the prevertebral muscles, to divide the thick investing periosteum.

The basilar portion of the occipital bone must now be divided by means of a chisel. Still retaining the part upside down, place the skull so that its floor rests upon the end of a wooden block. Then apply the edge of the chisel to the under surface of the basilar portion of the occipital bone, adjust it accurately in the interval between the pharyngeal wall and the prevertebral muscles, and with a wooden mallet drive it through the base of the skull, inclining it, at the same time, slightly backwards.

The next step in the dissection consists in making two saw-cuts through the cranial wall. The head having been placed upon its side, the saw must be applied to the lateral aspect of the skull, half an inch posterior to the mastoid process, and be carried obliquely forwards and medially to reach a point immediately posterior to the jugular foramen. A similar saw-cut must be made upon the opposite side of the head.

To complete the dissection the dissector must again use the chisel. Placing the preparation so that the floor of the cranial cavity looks upwards, divide the base of the skull, on each side, in the interval between the petrous portion of the temporal bone and the basilar portion of the occipital bone. Anteriorly, this cut should reach the lateral extremity of the incision already made through the basilar portion; whilst posteriorly, it should be carried to the medial side of the jugular foramen to reach the medial end of the corresponding saw-cut. When that has been done upon both sides of the basilar portion, the anterior part of the skull, carrying the pharynx and the great blood-vessels and nerves, can be separated from the posterior part of the skull and cervical portion of the vertebral column. The only large nerve which will be divided is the hypoglossal, but, as it is cut close to the basis cranii, and above its connection with the ganglion nodosum of the vagus, it retains its position.

The pharynx and anterior portion of the skull should now be covered with a piece of cloth soaked in preservative solution, and the whole enveloped in an oil-cloth wrapper. It can then be laid aside until the dissection of the prevertebral region and the ligaments of the cervical vertebræ and the occiput has been completed.

Returning to the posterior part of the skull and the cervical portion of the vertebral column, the dissector should proceed to define the attachments of the muscles which lie anterior to the transverse processes and the bodies of the vertebræ. They are three in number on each side, viz. :—

1. The longus colli.
2. The longus capitis (O.T. rectus capitis anticus major).
3. The rectus capitis anterior (O.T. anticus minor).

Musculus Longus Colli.—The longus colli is the most powerful of the prevertebral muscles of the neck, and it lies nearest to the median plane. Its connections are somewhat intricate, but when it has been thoroughly cleaned it will be seen to consist of three portions—viz., upper and lower oblique parts, and a middle vertical part.

The *lower oblique* division arises from the lateral aspect of the bodies of the upper two or three thoracic vertebræ. It extends upwards, and slightly laterally, and ends in two tendinous slips which are inserted into the anterior tubercles of the transverse processes of the fifth and sixth cervical vertebræ. In the interval between that portion of the longus colli and the scalenus anterior, the vertebral artery will be seen. The *upper oblique* part arises by three tendinous slips from the anterior tubercles of the transverse processes of the third, fourth, and fifth cervical vertebræ; it tapers somewhat as it proceeds upwards and medially to obtain a pointed and tendinous insertion into the anterior tubercle of

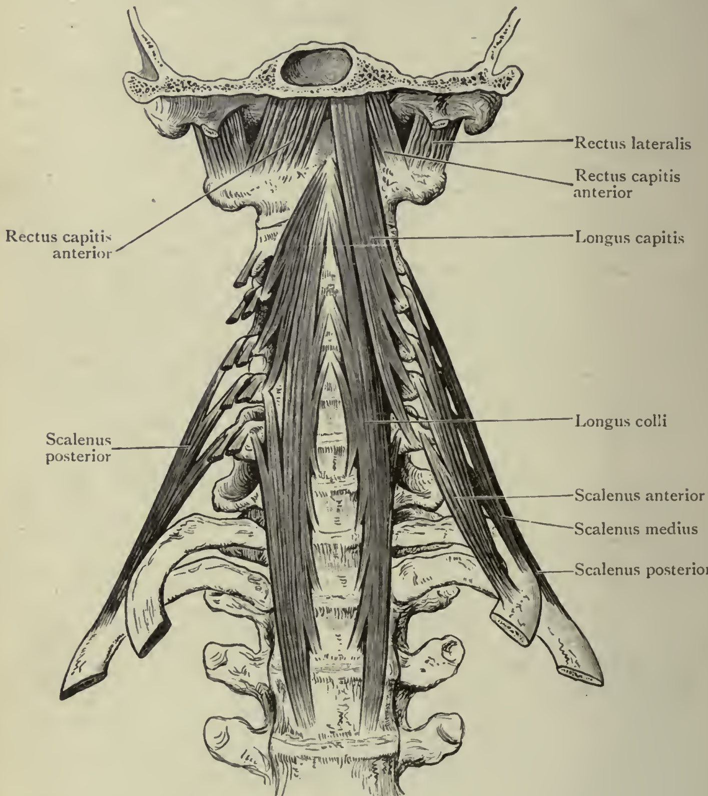


FIG. 99.—Prevertebral Muscles of the Neck. On the right side the longus capitis has been removed. (Paterson.)

the atlas. The *vertical part* of the muscle is much the largest of the three divisions. It lies along the medial side of the oblique portions, and is intimately connected with both of them. It arises, in common with the inferior oblique part, by two or three slips from the sides of the bodies of the upper two or three thoracic vertebræ; and it derives additional slips of origin from the bodies of the lower two cervical vertebræ; lastly, its lateral border is reinforced by slips from the transverse processes of the lower three or four cervical vertebræ. It passes vertically upwards, and is inserted upon the medial side of the upper oblique part of the muscle by three tendinous processes, which obtain attachment to the bodies of the second, third, and fourth cervical vertebræ. It is supplied by the anterior rami of the cervical nerves. It bends the neck forwards.

Longus Capitis (O.T. **Rectus Capitis Anticus Major**).—The longus capitis is an elongated muscle which arises by four tendinous slips from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ. It is inserted, anterior to the foramen magnum, upon the under aspect of the basilar portion of the occipital bone. To reach its insertion the muscle inclines slightly medially as it ascends upon the anterior aspect of the vertebral column (Fig. 99). It is supplied by twigs from the *first loop* of the *cervical plexus*. It bends the head forwards.

Rectus Capitis Anterior (O.T. **Anticus Minor**).—The rectus capitis anterior is a small muscle. It is partly concealed by the upper portion of the longus capitis, which should be detached from its insertion, and turned downwards so as to bring the capitis anterior fully into view. It arises from the anterior aspect of the lateral mass of the atlas and, proceeding upwards and medially, is inserted into the under surface of the basilar portion of the occipital bone, posterolateral to the longus capitis (Fig. 99). It is supplied by a filament from the *first loop* of the *cervical plexus*. It bends the head forwards.

Before proceeding farther, the dissector should again examine the attachments of the scalene muscles (*v.* p. 233).

Musculi Intertransversarii.—To obtain a proper display of the intertransverse muscles the prevertebral and scalene muscles must be removed. The intertransverse muscles, on each side, consist of seven pairs of small fleshy slips which connect the bifid extremities of the cervical transverse processes; they are the anterior and posterior intertransverse muscles. Each anterior muscle is attached to the anterior tubercles of two adjacent transverse processes; whilst the posterior extends between the posterior tubercles. The highest pair of muscular slips lies between the atlas and the epistropheus; the lowest pair connects the transverse process of the seventh cervical vertebra with the transverse process of the first thoracic vertebra.

Nervi Cervicales.—The cervical spinal nerves have a very definite relation to the intertransverse muscles. The anterior rami of the lower seven nerves make their appearance, by passing laterally, *between* the two corresponding muscles. The posterior divisions of the same nerves turn backwards, medial to the posterior muscles.

The upper two cervical nerves emerge from the vertebral canal differently from the others. They pass laterally over the posterior arch of the atlas and the vertebral arch of the epistropheus, respectively, behind the articular processes, whilst the lower nerves are situated in front of the articular processes.

The anterior ramus of the first cervical nerve passes forwards medial to the rectus capitis lateralis, and then turns downwards to join the anterior ramus of the second cervical nerve, with which it forms the first loop of the cervical plexus. The posterior ramus passes backwards into the sub-occipital triangle. The anterior ramus of the second cervical nerve passes laterally between the first pair of intertransverse muscles, and the posterior ramus runs backwards medial to the first posterior intertransverse muscle.

Dissection.—The vertebral artery as it traverses the succession of foramina in the transverse processes of the cervical vertebræ should now be exposed. Remove the intertransverse muscles as well as the muscles still attached to the transverse process of the atlas—viz., the rectus lateralis, the inferior oblique, and the superior oblique. The anterior tubercles and the costal portions of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ should then be snipped off with the bone forceps.

Arteria Vertebralis.—The vertebral artery is a vessel of great importance, for, together with its fellow of the opposite side and the basilar artery, which is formed by their union, it supplies the hind-brain, the mid-brain, and the posterior parts of the cerebral hemispheres, and it helps to supply the spinal medulla. It commences at the root of the neck, as a branch of the first part of the subclavian artery, and it runs upwards, through the transverse processes of the upper six cervical vertebræ, to the base of the skull. It enters the skull through the foramen magnum and unites, in the posterior fossa of the cranium, at the lower border of the pons, with its fellow of the opposite side to form the basilar artery. On account of its varying relations it is divided into four parts. The *first part*, which extends from the subclavian artery to the transverse process of the sixth cervical vertebra, has been seen already (p. 154). It lies between the longus colli medially, the scalenus anterior laterally, the transverse process of the seventh cervical vertebra and the inferior cervical ganglion of

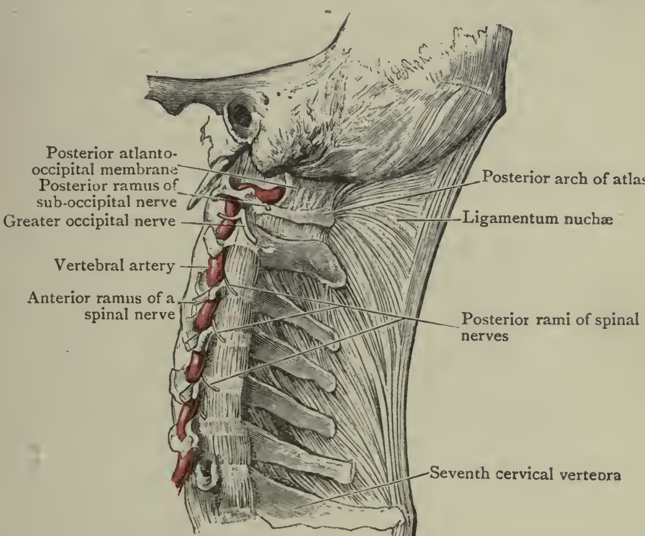


FIG. 100.—Dissection of the Ligamentum Nuchæ and of the Vertebral Artery in the Neck.

the sympathetic posteriorly, and the vertebral vein and the common carotid artery anteriorly (Figs. 53, 54).

The *second part*, now exposed, commences where the artery enters the transverse process of the sixth cervical vertebra. It passes vertically upwards, through the series of foramina transversaria, till it reaches the foramen in the transverse process of the epistropheus. In that it runs laterally, as well as upwards, to gain the foramen in the more laterally placed transverse process of the atlas; and, as it emerges upon the upper aspect of the atlas (Figs. 56, 100), the *third part* commences and curves round the lateral and posterior aspects of the corresponding upper articular process of the atlas, in a groove upon the upper surface of its posterior arch (Figs. 20, 38). As soon as it has passed under cover of the lateral margin of the posterior atlanto-occipital membrane it becomes the *fourth part.* The fourth part turns upwards, pierces the dura mater, and passes into the skull through the foramen magnum, anterior to the uppermost digitation of the ligamentum denticulatum; then, turning antero-medially, between the hypoglossal nerve above and the first cervical nerve below, it passes to the anterior surface of the medulla oblongata, and, as already stated, joins its fellow of the opposite side at the lower border of the pons (Figs. 37, 144).

Relations.—The relations of the first part have already been sufficiently considered. The second part lies in and between the transverse processes of the cervical vertebræ, medial to the intertransverse muscles, lateral to the bodies of the vertebræ, and anterior to the anterior rami of the cervical nerves as they pass laterally. It is surrounded not only by the sympathetic nerve plexus derived from the inferior cervical ganglion, which accompanies all parts of the artery, but also by a venous plexus which terminates, below, as the vertebral vein or veins. The third part of the artery lies on the posterior arch of the atlas in the anterior boundary of the sub-occipital triangle. As it turns backwards, from the foramen in the transverse process of the atlas, the anterior ramus of the first cervical nerve lies to its medial side, between it and the lateral mass of the atlas; and, as it turns medially, posterior to the upper articular facet of the atlas, the trunk of the first cervical nerve lies below it, on the posterior arch of the atlas, and the posterior ramus enters the triangle from beneath its lower border. For the relations of the fourth part see the preceding paragraph and pp. 117, 382.

Branches.—No branch of importance is given off from the first part. The second part gives off lateral spinal (p. 90) and muscular branches. The branches from the third part are muscular twigs, and branches to anastomose with twigs from the occipital and the deep cervical arteries. The fourth part gives off a meningeal branch before it perforates the dura mater and, afterwards, a series of branches to the central nervous system (see pp. 382, 383).

Vena Vertebralis.—Only the first part of the vertebral artery is accompanied by a definite vertebral vein. There are no accompanying veins with the fourth part of the artery, but a plexus is formed round the commencement of the third part, by the union of tributaries from the venous plexus in the vertebral canal and from the plexus of veins in the sub-occipital triangle. The plexus accompanies the second part of the artery through the transverse processes of the cervical vertebræ; it anastomoses with the venous plexuses in the vertebral canal; and it terminates, below, as one or two vertebral veins. The vertebral veins accompany the first part of the artery and end in the posterior aspect of the commencement of the innominate vein.

Dissection.—The muscles must now be completely removed, in order that the vertebral and cranio-vertebral joints, and the ligaments in connection with the cervical portion of the vertebral column, may be examined.

THE JOINTS OF THE NECK.

The epistropheus, atlas, and occipital bone present a series of articulations in which the uniting apparatus is very different from that of the vertebræ below.

Articulations of the Lower Five Cervical Vertebræ.—The lower five cervical vertebræ are united together very much upon the same plan as the vertebræ in other regions of the vertebral column. The bodies and the vertebral arches are connected by distinct articulations and special ligaments.

Three separate joints may be said to exist between the opposed surfaces of the *bodies* of two adjacent cervical vertebræ—viz., a central synchondrosis and two small collateral diarthrodial joints.

The *synchondrosis* occupies by far the greatest part of the interval between the vertebral bodies, and it presents the usual characters of such an articulation. The opposed bony surfaces are coated with a thin layer of hyaline or encrusting cartilage, and are connected together by an interposed disc of fibro-cartilage. The intervertebral fibro-cartilages are distinctly deeper anteriorly than posteriorly, and upon that circumstance the cervical curvature of the column in great measure depends.

The two *diarthrodial joints* are placed, one on each side, where the disc of fibro-cartilage is absent. They are of small extent, and are confined entirely to the intervals between the projecting lateral lips of the upper surface of the body and the bevelled-off lateral margins of the lower surface of the vertebral body immediately above. The bony surfaces are coated with encrusting cartilage, and are separated by a synovial cavity enclosed by a feeble articular capsule.

The *ligaments* which bind the bodies of the lower five cervical vertebræ together are the direct continuation upwards of the anterior and the posterior longitudinal ligaments of the vertebræ. When the medulla spinalis was removed, the laminæ of the vertebræ, below the epistropheus, were

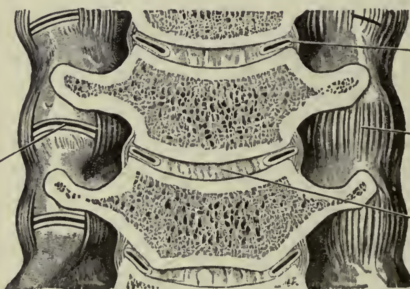


FIG. 101.—Frontal section through bodies of certain of the Cervical Vertebræ.

taken away, so that very little dissection will be required to make out the connections of both of the ligaments mentioned. The *anterior longitudinal ligament* is a strong band placed on the anterior faces of the vertebral bodies. It is more firmly fixed to the intervening intervertebral fibro-cartilages than to the bones. The *posterior longitudinal ligament*, which lies on the posterior aspects of the vertebral bodies, constitutes the anterior boundary of the vertebral canal. In the cervical region it completely covers the bodies and does not present the denticulated appearance which is so characteristic lower down. It is attached chiefly to the fibro-cartilages and the adjacent margins of the bones.

The *vertebral arches* of the lower five cervical vertebræ are bound together by (*a*) the articulations between the articular processes; (*b*) ligamenta flava; (*c*) interspinous ligaments, and (*d*) intertransverse ligaments; (*e*) ligamentum nuchæ.

The *joints* between the opposing articular processes are of the diarthrodial variety. The surfaces of bone are coated with cartilage; there is a joint cavity surrounded by a distinct articular capsule, lined with a synovial stratum. The capsule is more laxly arranged in the neck than in the lower regions of the vertebral column.

The *ligamenta flava* may be examined on the laminæ which were removed for the display of the spinal medulla, and which the dissector was directed to retain. They fill up the gaps between the laminæ of the vertebræ, and can be seen best when the anterior aspect of the specimen is viewed.

Ligamenta Flava.—The ligamenta flava are composed of

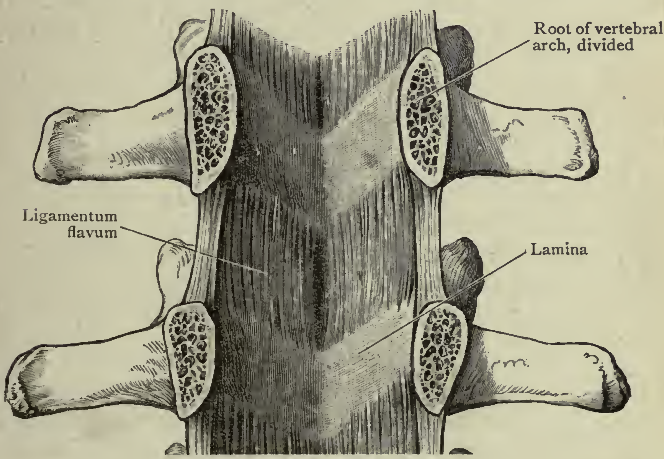


FIG. 102.—The Ligamenta Flava in the Lumbar Region.

yellow elastic tissue. Each is attached superiorly to the anterior surface and inferior margin of the lamina of the vertebra above, whilst inferiorly it is fixed to the posterior surface and superior margin of the lamina of the vertebra next below. The laminæ and the ligaments form, together, a smooth, even, posterior wall for the vertebral canal. Each ligament extends from the posterior part of the articular processes to the median plane, where its free thickened median border is in contact with its fellow of the opposite side. The median slit between them, in the space between each pair of vertebral arches, is filled with some lax connective tissue, which allows the egress from the vertebral canal of some small veins. The width of the ligaments in the different regions of the vertebral column depends upon the size of the vertebral canal. Therefore, they are widest in the neck and in the lumbar part of the column. The ligamenta flava, by virtue of their great strength and elasticity, are powerful agents in maintaining the curvatures of the vertebral column; they also give valuable aid to the muscles in restoring the vertebral column to its original position after it has been bent in a ventral direction.

The *interspinous ligaments* are most strongly developed in the lumbar region, where they fill up the intervals between the adjacent margins of contiguous spinous processes. In the thoracic region, and more so in the neck, they are very weak.

The *supraspinous ligaments* are thickened bands which connect the summits of the spinous processes. In the neck they are replaced by the ligamentum nuchæ (p. 67).

The *intertransverse ligaments* are feebly marked in the cervical region and extend chiefly between the anterior bars of the transverse processes.

Articulations of the Epistropheus, Atlas, and Occipital Bone.—The articulations which exist between the atlas and the occipital bone and the atlas and the epistropheus all belong to the diarthrodial class. Between the atlas and epistropheus (O.T. axis) there are three such joints—viz., a pair between the opposed articular processes, and a third between the anterior face of the dens and the posterior face of the anterior arch of the atlas. Between the atlas and occipital bone there is a pair of joints—viz., between the occipital condyles and the elliptical cavities upon the upper aspects of the lateral masses of the atlas. In addition, the epistropheus is attached to the occipital bone by ligaments.

The ligaments connecting the three bones together may be divided into three main groups, as follows:—

Ligaments connecting atlas with epistropheus, . . .
- Anterior longitudinal.
- Ligamenta flava.
- Capsular.
- Transverse portion of cruciate ligament with inferior crus.
- Accessory ligaments of the atlanto-epistropheal joints.

Ligaments connecting occipital bone with atlas, . .	Anterior longitudinal ligament. Anterior atlanto-occipital membrane. Posterior atlanto-occipital membrane. Transverse part of cruciate ligament with superior crus. Capsular.
Ligaments connecting occipital bone with epistropheus, ...	Membrana tectoria. Superior and inferior crus of the cruciate ligament. Alar. Apical.

Ligamentum Longitudinale Anterius (Fig. 103).—The anterior longitudinal ligament is a continuation upwards of the common anterior longitudinal ligament. Below, it is attached to the anterior aspect of the body of the epistropheus, whilst above, it is fixed to the anterior arch of the atlas. It is thick and strong in the middle, but thins off towards the sides.

Ligamenta Flava.—The yellow ligaments fill the interval between the laminæ of the epistropheus and the posterior arch of the atlas, to the contiguous margins of which they are attached. They are broader and more membranous than the ligamenta flava at lower levels.

Capsulæ Articulares.—The articular capsules are somewhat lax, and are attached to the margins of the articular processes.

Membrana Atlanto-Occipitalis Anterior (Fig. 103).—The anterior occipito-atlantal membrane extends from the upper border of the anterior arch of the atlas to the under surface of the basilar portion of the occipital bone, anterior to the foramen magnum. On each side of the median plane it is thin and membranous, and stretches laterally so as to abut against the atlanto-occipital articular capsule. In the median plane it is strengthened by the upper part of the anterior longitudinal ligament.

Membrana Atlanto-Occipitalis Posterior.—The thin and weak posterior occipito-atlantal membrane occupies the gap between the posterior arch of the atlas and the posterior border of the foramen magnum, to both of which it is attached. It is very firmly connected with the dura mater, and on each side it reaches the atlanto-occipital articular capsule. Each of its lateral borders forms an arch over the groove, posterior to the upper articular facet of the atlas, in which the vertebral artery and the first cervical nerve are lodged. It is not uncommon to find the borders ossified.

Atlanto-Occipital Articular Capsules.—The atlanto-occipital capsules connect the occipital condyles with the lateral masses of the atlas. They completely surround the joints, and are connected anteriorly with the anterior atlanto-occipital membrane, and posteriorly with the posterior atlanto-occipital membrane.

The occipital bone, therefore, around the foramen magnum is attached by special ligaments to each of the four portions

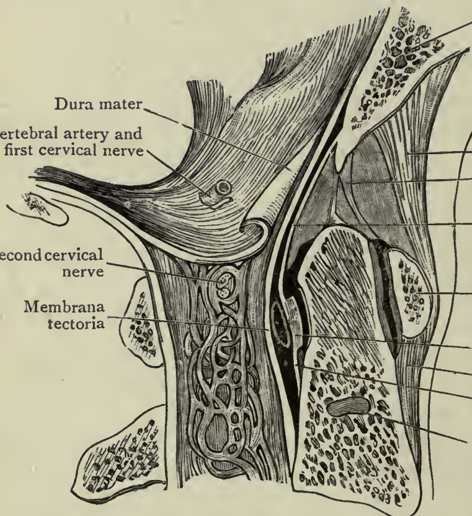


FIG. 103.—Median section through the Basilar Portion of Occipital Bone, the Atlas and the Epistropheus. (From Luschka, slightly modified.)

Between the membrana tectoria and the transverse ligament a small synovial bursa may be seen.

of the atlas—viz., to the anterior arch, to the two lateral masses, and to the posterior arch.

Dissection.—The remaining ligaments are placed within the vertebral canal, in connection with its anterior wall. For their proper display it is necessary therefore to remove, with the bone forceps, the laminæ of the epistropheus and the posterior arch of the atlas. The squamous part of the occipital bone also must be taken away, by sawing it through, on each side, immediately posterior to the jugular process and the condyle, carrying the saw cut into the foramen magnum. The upper part of the tube of dura mater, which still remains in the vertebral canal, must next be carefully detached. When that has been done, a broad membranous band stretching upwards over the posterior aspect of the body and dens of the epistropheus is displayed. This is the membrana tectoria.

The Membrana Tectoria (O.T. **Posterior Occipito-axial Ligament**).—The tectorial membrane is a broad ligamentous sheet which is attached, below, to the posterior aspect of the body of the epistropheus, where it is continuous with the posterior longitudinal ligament of the vertebræ. It extends upwards, covering the dens and the anterior margin of the foramen magnum, and is attached, above, to the superior grooved surface of the basilar portion of the occipital bone.

Dissection.—Detach the tectorial membrane from the epistropheus and throw it upwards upon the basilar portion of the occipital bone. By that proceeding the accessory ligaments of the atlanto-epistropheal joints and the cruciate ligament will be brought into view, and very little further dissection is required to define them.

Accessory Atlanto-epistropheal Ligaments (Fig. 104).—The accessory atlanto-epistropheal ligaments are two strong bands which take origin from the posterior aspect of the body of the epistropheus, close to the base of the dens. Each band passes upwards and laterally, and is attached to the medial and posterior part of the corresponding lateral mass of the atlas. To a certain extent they assist the alar ligaments in limiting the rotary movements of the atlas upon the epistropheus.

Ligamentum Cruciatum (Fig. 104).—The cruciate ligament is composed of a transverse and a vertical part. The transverse part is by far the most important constituent. It is a strong band which stretches from the tubercle on the medial aspect of the lateral mass of the atlas on one side to the corresponding tubercle on the opposite side. With the anterior arch of the atlas, it forms a ring which encloses the dens—the pivot around which the atlas, bearing the head, turns. It is separated from the posterior aspect of the dens by a loose synovial membrane which extends forwards, on each side, until it almost reaches the synovial membrane in connection with the median joint between the dens and the anterior arch of the atlas. Indeed, in some cases a communication exists between the two synovial cavities.

The *vertical part* of the cruciate ligament consists of an upper and a lower limb, which are termed the crura. Both are attached to the dorsal surface of the transverse ligament. The *crus superius* is the longer and flatter of the two, and extends upwards on the posterior aspect of the dens to be attached to the upper aspect of the basilar part of the occipital bone, immediately beyond the anterior margin of the foramen magnum. The *crus inferius*, much shorter, extends downwards, and is fixed to the posterior aspect of the body of the epistropheus.

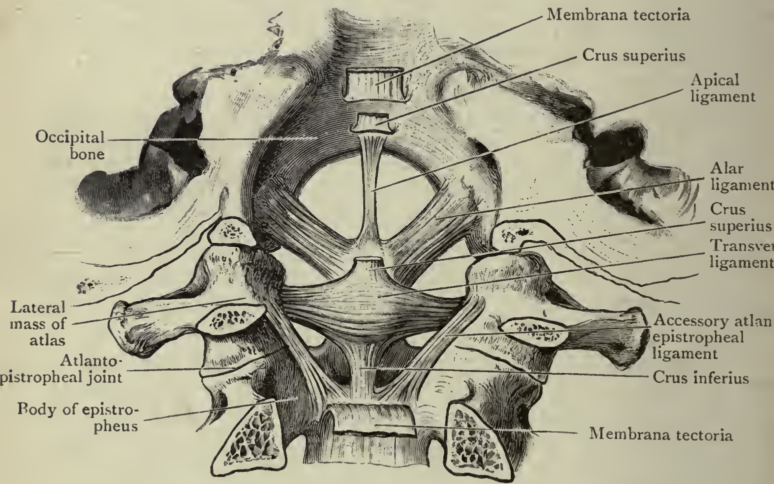


FIG. 104.—Dissection showing the posterior aspects of the Ligaments connecting the Occipital Bone, the Atlas and the Epistropheus with each other.

Dissection.—Detach the superior crus from the occipital bone, and throw it downwards. The apical ligament is thus displayed, and a better view of the alar ligaments is obtained.

Ligamentum Apicis Dentis.—The apical ligament of the dens consists of two parts—an anterior and a posterior. The *posterior part* is a rounded cord-like ligament which is attached, below, to the summit of the dens, and, above, to the anterior margin of the foramen magnum. Inasmuch as it is developed around the continuation of the notochord, from the dens to the basis cranii, it is a structure of considerable morphological interest. The *anterior part* of the apical ligament is a flat and weak band which is attached, above, to the anterior margin of the foramen magnum at the same point as the posterior portion. Below, the two portions are separated by an interval filled with areolar tissue, and the anterior part is attached to the dens immediately above its articular facet for the anterior arch of the atlas.

Ligamenta Alaria (Fig. 104).—The alar ligaments are very powerful bands which spring, one from each side of the summit of the dens. Each passes laterally and slightly upwards to be attached to the medial aspect of the corresponding condyloid eminence of the occipital bone. The alar ligaments limit rotation of the head, and in this they are aided by the accessory atlanto-epistropheal ligaments.

Movements.—Nodding movements of the head are permitted at the atlanto-occipital articulations. Rotatory movements of the head and atlas around the dens, which acts as a pivot, take place at the atlanto-epistropheal joints. Excessive rotation is checked by the alar ligaments.

MOUTH AND PHARYNX.

The dissectors must now return to the anterior part of the skull, which had been laid aside while the dissection of the prevertebral region was being carried on. The mouth and pharynx should engage their attention in the first instance.

Mouth.—The mouth is the expanded upper part of the alimentary canal which is placed in the lower part of the face, below the nasal cavities. Its cavity is controlled by muscles which are under the influence of the will, and it is separable into two parts: a smaller external part, termed *the vestibule*, which is bounded externally by the lips and cheeks, and internally by the teeth and gums; and a large part, the *mouth proper*, which is placed within the teeth.

The mucous lining of the mouth should be thoroughly cleansed, and the two subdivisions of the cavity examined through the *oral fissure*.

Vestibulum Oris.—The *vestibule* of the mouth, which lies outside the teeth and gums, is a mere fissure-like space, except when the cheeks are inflated with air. It is into the vestibule of the mouth that the parotid ducts open (p. 164). *Above* and *below*, it is bounded by the reflection of the mucous membrane from the lips and cheeks on to the alveolar margins of the maxillæ and mandible. *Anteriorly*, it opens upon the face by means of the oral fissure; whilst *posteriorly*, it communicates, on each side, with the cavity of the mouth proper through the interval between the last molar tooth and the anterior border of the ramus of the mandible. The existence of that communicating aperture is of importance in cases of spasmodic closure of the jaws, when all the teeth are in place, because through it fluids may be introduced into the posterior part of the mouth proper.

In paralysis of the facial muscles the lips and cheeks fall away from the dental arches and food is apt to lodge in the vestibule.

Cavum Oris Proprium.—The *mouth proper* is bounded, anteriorly and laterally, by the gums and teeth, whilst, posteriorly, it communicates, by means of the *isthmus of the fauces*, with the pharynx. The *floor* is formed by the tongue and the mucous membrane which connects it with the inner aspect of the mandible; the *roof* is vaulted, and is formed by the hard and the soft palates. It is into the mouth proper that the ducts of the submaxillary glands and the ducts of the sublingual glands open (p. 194). When the mouth is closed the dorsum of the tongue is usually applied more or less closely to the palate and the cavity is almost completely obliterated.

The various parts which bound the oral cavity may now be examined in turn.

Labia Oris.—The structure of the lips has, in a great measure, been examined already in the dissection of the face (p. 10). Each lip is composed of four layers: (1) Cutaneous; (2) muscular; (3) glandular; and (4) mucous. The *skin* and *mucous membrane* become continuous with each other at the free margin of the lip. The mucous membrane is reflected from the inner aspect of the upper lip to the alveolar margin of the maxillæ, and from the inner aspect of the lower lip to the mandible. In each case it is raised in the median plane in the form of a free fold termed the *frenulum*. The *muscular layer* constitutes the chief bulk of the lips. It is formed by the orbicularis oris and the various muscles which converge upon the oral fissure. Numerous *labial glands* lie in the submucous tissue which intervenes between the mucous membrane and the muscular fibres. The ducts of those glands pierce the mucous membrane and open into the vestibule. In each lip there is an arterial arch formed by the corresponding labial arteries (p. 16).

The lymph vessels of both lips join the submaxillary lymph glands, but some of the lymph vessels of the upper lip pass to the superficial parotid glands.

Buccæ.—Six layers can be distinguished in the cheeks, four of which were examined in the dissection of the face. They are—(1) Skin; (2) a fatty layer, traversed by some of the facial muscles and by the external maxillary artery; (3) the bucco-pharyngeal fascia; (4) the buccinator muscle; (5) the submucous tissue, in which lie numerous *buccal glands* similar in character to the labial glands; (6) the mucous membrane. Four or five mucous glands of larger size, termed the *molar glands*, occupy a more superficial position. They lie either external or internal to the bucco-pharyngeal fascia, close to the point where it is pierced by the parotid duct, and their ducts open into the vestibule of the mouth. The *bucco-pharyngeal fascia* is a dense membrane which covers the buccinator muscle. Above and below, it is attached to the alveolar portions of the maxilla and mandible respectively, whilst posteriorly it is continued over the pharynx. The muscles which traverse the *fatty layer* are chiefly the zygomaticus, the risorius, and the posterior fibres of the platysma. The parotid duct pierces the inner four layers of the cheek, and opens into the vestibule of the mouth, opposite the second molar tooth of the maxilla.

Gingivæ et Dentes.—The gums are covered with a smooth and vascular mucous membrane, which is firmly bound down to the subjacent periosteum of the alveolar portions of the jaws by a stratum of dense connective tissue. It is continuous, on the one hand, with the mucous membrane of the lips and cheeks, and, on the other, with the mucous membrane of the mouth proper. The gums closely embrace the necks of the teeth.

In the adult, the teeth in each jaw number sixteen. From the median line backwards, on each side, they are the two incisors, the canine, the two præmolars, the three molars.

Floor of the Mouth.—The mucous membrane is reflected from the inner aspect of the mandible to the side of the tongue; but in the anterior part of the mouth the tongue lies more or less free in the oral cavity, and there the mucous membrane stretches across the floor from one half of the mandible to the other. On each side, in the anterior region, the projection formed by the sublingual gland, *the plica sub-*

lingualis, can be distinguished. Further, if the tongue is pulled upwards, a median fold of mucous membrane will be seen to connect its under surface to the floor. It is the *frenulum linguæ.* At the sides of the frenulum the dissector must look for the openings of the submaxillary ducts. Each terminates on a papilla placed close to the side of the frenulum. More posteriorly, between the side of the tongue and the mandible and on the summit of the plica sublingualis, are the openings of the sublingual ducts.

Roof of the Mouth.—The hard and the soft palates form

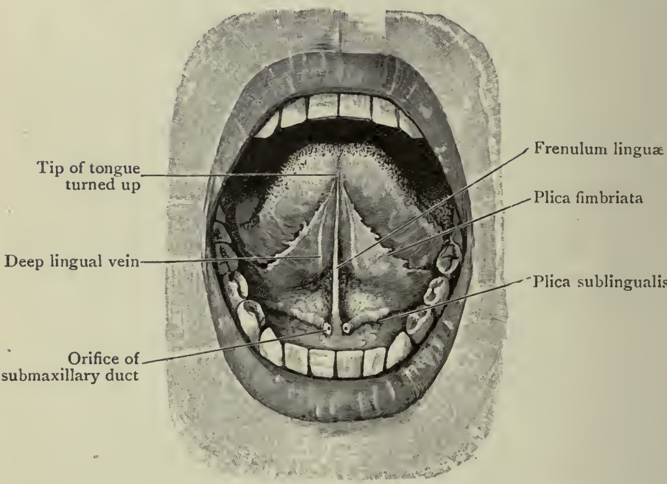


FIG. 105.—The Sublingual Region in the Interior of the Mouth.

the continuous concave and vaulted roof of the mouth (Fig. 106). Projecting from the middle of the posterior free margin of the soft palate, and resting upon the dorsum of the tongue, the *uvula* will be seen (Fig. 106). Running along the median line of both the hard and the soft palates is a raphe which terminates anteriorly, opposite the incisive foramen of the hard palate, in a slight elevation or papilla termed the *incisive papilla.* In the anterior part of the hard palate the mucous membrane, on each side of the raphe, is thrown into three or four transverse hard corrugations or ridges; more posteriorly it is comparatively smooth. By carefully palpating the postero-lateral angles of the palate the dissector will be able to feel the hamuli of the medial pterygoid laminæ.

Isthmus Faucium.—*The isthmus of the fauces* is the name given to the communication between the mouth proper and the pharynx (Fig. 106). To obtain a good view of it the mouth must be well opened and the tongue depressed. The isthmus faucium and the parts which bound it can be examined best in the living subject, and the dissector should study his own isthmus faucium with the aid of a looking-glass

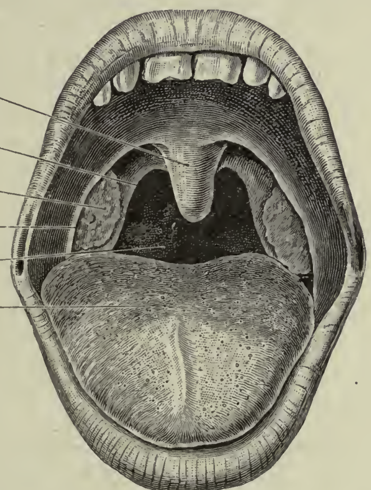


FIG. 106.—Isthmus of the Fauces as seen through the widely opened Mouth. The palatine tonsils, in the subject from which this drawing was made, were somewhat enlarged.

(Fig. 106). It is bounded above by the soft palate, below by the dorsum of the tongue, and on each side by a curved fold of mucous membrane, termed the arcus glossopalatinus (O.T. anterior pillar of the fauces).

Each *glosso-palatine arch* descends from the posterior part of the inferior surface of the soft palate and, inclining forwards as it descends, it ends upon the side of the posterior part of the tongue. It encloses the glosso-palatinus muscle.

The *pharyngo-palatine arches* which are also described as boundaries of the isthmus of the fauces lie, in reality, on the side wall of the oral part of the pharynx. They pass downwards and backwards from the sides of the lower margin of the soft palate, and each encloses a pharyngo-palatine muscle.

In the triangular interval which is formed by the divergence of the glosso- and pharyngo-palatine arches, on each side, lies a *palatine tonsil.*

Strictly speaking, the term *isthmus faucium* should be confined to the interval between the two glosso-palatine arches, as the palatine tonsil and the pharyngo-palatine arches belong to the side wall of the pharynx.

Pharynx.—The pharynx is a wide musculo-aponeurotic canal, about 12.5 cm. (5 inches) long. It extends from the base of the cranium to the level of the body of the sixth cervical vertebra (Fig. 110). There, at the lower border of the cricoid cartilage, it becomes continuous with the œsophagus. It is placed posterior to the nasal cavities, the mouth and the larynx, and it serves as the passage which conducts air to and from the larynx, as well as the food from the mouth to the œsophagus.

Under ordinary conditions it is expanded from side to side and compressed antero-posteriorly, so that it possesses anterior and posterior walls and two borders. Above the level of the orifice of the larynx there is always sufficient space for the passage of air to the lungs, but below the orifice of the larynx the anterior and posterior walls are in contact, except when separated by the passage of food (Fig. 112).

It is widest above, at the base of the cranium, posterior to the orifices of the auditory tubes (O.T. Eustachian). Thence it narrows to the level of the hyoid bone. It widens again at the level of the upper part of the larynx and then rapidly narrows to its termination.

To obtain a proper idea of the connections of the pharynx, the dissector should distend its walls moderately by stuffing it with tow. This may be introduced either from above, through the mouth, or from below, through the œsophagus.

When the pharynx is distended it has a somewhat ovoid form. *Posteriorly*, its wall is complete, and, when in position, it lies anterior to the upper six cervical vertebræ, the prevertebral muscles, and the prevertebral fascia. It is bound to the prevertebral fascia by some lax connective tissue which offers no impediment to the movements of the canal during the process of deglutition. *On each side*, the pharynx is related to the great vessels and nerves of the neck, as well as to the styloid process and the muscles which take origin from it; and the pharyngeal plexus of nerves ramifies over its margin, extends on to its surfaces, and supplies it with motor and sensory twigs. *Anteriorly*, the pharyngeal wall is interrupted by the openings of the nasal cavities, mouth, and larynx; and it is from the structures which lie in proximity to those apertures that it derives its principal attachments. From above downwards it is attached, on each side—(*a*) to the medial pterygoid lamina; (*b*) to the pterygo-mandibular raphe; (*c*) to the side of the tongue; (*d*) to the medial aspect of the mandible; (*e*) to the hyoid bone; (*f*) to the thyreoid cartilage; (*g*) to the cricoid cartilage. *Above*, it is attached to the basis cranii. The various attachments will be studied more fully when the constituent parts of its walls are dissected.

It should be recognised that an altogether false idea of the natural form of the pharynx is obtained when it is removed from the vertebral column and is stuffed with tow or other substances. In transverse sections of the frozen body it will be noted that the cavity of the nasal part of the pharynx remains patent under all conditions, whilst at lower levels the anterior wall is more or less nearly approximated to the posterior wall, and below the opening of the larynx the cavity of the pharynx presents the appearance of a simple transverse slit.

Pharyngeal Wall.—The wall of the pharynx consists of four well-marked strata. From without inwards they are: (1) bucco-pharyngeal fascia; (2) pharyngeal muscles; (3) pharyngeal aponeurosis; (4) mucous membrane. The muscular layer, which is composed of the three constrictor muscles, with the stylo-pharyngeus and pharyngo-palatinus, on each side, must now be dissected.

Bucco-pharyngeal Fascia.—The bucco-pharyngeal fascia is a coating of fibrous tissue which covers both the buccinator and the pharyngeal muscles.

Dissection.—Remove the bucco-pharyngeal fascia and clean the pharyngeal muscles, sweeping the knife in the direction of their fibres. Note the veins which lie between the fascia and the muscles, forming the pharyngeal plexus, and the pharyngeal plexus of nerves to which the pharyngeal branches of the vagus nerve, the glosso-pharyngeal nerve, and the superior cervical sympathetic ganglion have already been traced. The veins and nerves must be removed for the proper display of the muscles.

Venæ Pharyngeæ.—The pharyngeal veins lie mostly upon the posterior wall and the borders of the pharynx, where they anastomose together in a plexiform manner. They constitute, collectively, the *pharyngeal venous plexus*, which receives blood from the pharynx, soft palate, and prevertebral region. It communicates with the pterygoid plexus and the cavernous

a. Buccinator.
b. Tensor veli palatini.
c. Levator veli palatini.
d. Superior constrictor.
e. Middle constrictor.
f. Inferior constrictor.
g. Thyreo-hyoid.
h. Hyoglossus.
k. Stylo-hyoid.
l. Mylo-hyoid.
m. Crico-thyreoid.
n. Stylo-pharyngeus.
o. Stylo-glossus.
p. Stylo-hyoid ligament.
q. Pterygo-mandibular raphe.
1. Glosso-pharyngeal nerve.
2. Superior laryngeal artery.
3. Superior laryngeal nerve.
4. External laryngeal nerve.
5. Inferior laryngeal nerve and artery.

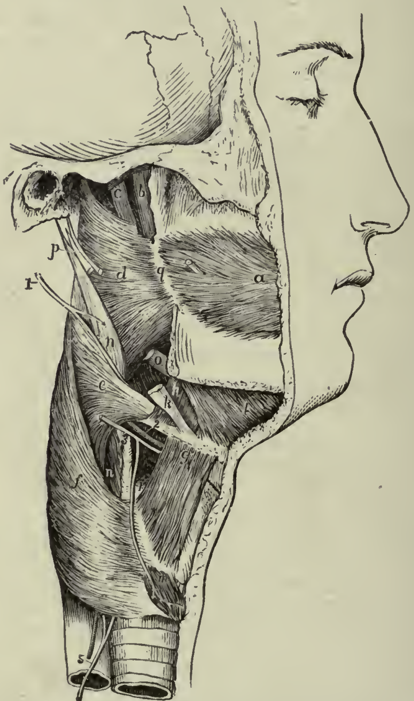


FIG. 107.—Profile view of the Pharynx to show the Constrictor Muscles. (From Turner.)

sinus. Two or more channels carry the blood from it to the internal jugular vein.

Constrictor Muscles.—The constrictor muscles are three pairs of curved sheets of muscular fibres which are so arranged that they overlap each other from below upwards; thus, the inferior constrictor overlaps the lower part of the middle constrictor, whilst the middle constrictor, in turn, overlaps the lower part of the superior constrictor. The three muscles are inserted, in the median plane, into the median raphe which descends from the basilar portion of the occipital bone along the posterior aspect of the pharynx.

Musculus Constrictor Pharyngis Inferior (Fig. 107, *f*).—The inferior constrictor muscle is relatively short, anteriorly, at its origin, and relatively long, posteriorly, where it blends with the fellow of the opposite side in the median raphe of the posterior wall of the pharynx. It arises from the posterior part of the side of the cricoid cartilage, and from the inferior cornu, the oblique line, and the upper border of the thyreoid cartilage. The muscle curves backwards and medially, in the pharyngeal wall, to meet its fellow of the opposite side in the median raphe. The lower fibres take a horizontal direction, but the remainder ascend, with increasing degrees of obliquity, until the highest fibres reach the raphe at a point a short distance below the base of the skull. The lower margin of the inferior constrictor overlaps the commencement of the œsophagus, and the inferior laryngeal nerve and the laryngeal branch of the inferior thyreoid artery pass upwards, under cover of it, to reach the larynx. It is supplied by twigs from the pharyngeal plexus and the recurrent nerve.

Musculus Constrictor Pharyngis Medius.—The middle constrictor is a fan-shaped muscle (Fig. 107, *e*). It arises from the greater and lesser cornua of the hyoid bone and from the lower part of the stylo-hyoid ligament. From those origins its fibres pass round the pharyngeal wall, to be inserted with the corresponding fibres of the opposite side into the median raphe. As they curve backwards and medially, the lowest fibres descend, the highest ascend, and the intermediate fibres run horizontally. The lower portion of the muscle is overlapped by the inferior constrictor, and in the interval which separates the margins of the muscles anteriorly, opposite the thyreo-hyoid interval, the internal laryngeal nerve and the laryngeal branch of the superior thyreoid artery will be seen piercing the thyreo-hyoid membrane to gain the interior of the pharynx. It is supplied by twigs from the pharyngeal plexus.

Dissection.—To bring the extensive origin of the superior constrictor fully into view the internal pterygoid muscle must be cut through about its middle, if that has not been done already

(p. 199), and then the upper and lower portions must be turned aside.

Musculus Constrictor Pharyngis Superior (Fig. 107, *d*).—The superior constrictor has a weak but continuous line of origin from the following parts: (*a*) the lower third of the posterior border of the medial pterygoid lamina and its hamulus; (*b*) the pterygo-mandibular raphe, which is common to it and the buccinator muscle; (*c*) the posterior end of the mylo-hyoid line on the medial aspect of the mandible; (*d*) the mucous membrane of the mouth and side of the tongue. From their origins, the fibres curve backwards and medially to reach the median raphe, whilst, as a rule, some of the highest gain a distinct insertion into the pharyngeal tubercle on the under surface of the basilar portion of the occipital bone.

The lower part of the superior constrictor is overlapped by the middle constrictor; and the stylo-pharyngeus passes into the interval between the two as it descends to its insertion (Fig. 107, *n*). The upper border of the muscle, which is free and crescentic, falls short of the base of the skull.

Raphe Pterygo-mandibularis (Fig. 107, *q*).—The pterygo-mandibular raphe is a strong, narrow, tendinous band, which extends from the hamulus of the medial pterygoid lamina to the posterior part of the mylo-hyoid line of the mandible. It acts as a tendinous bond of union between the buccinator and superior constrictor muscles. Its connections can be appreciated best by introducing the finger into the mouth and pressing laterally along the course of the raphe.

Sinus of Morgagni.—The term sinus of Morgagni is applied to the semilunar interval which intervenes between the basis cranii and the upper crescentic margin of the superior constrictor. The deficiency in the muscular wall of the pharynx in that region is compensated for by the increased strength of the pharyngeal aponeurosis, which, in that situation, is called the *pharyngo-basilar fascia*. In contact with the outer surface of the aponeurosis are two muscles belonging to the soft palate—viz. the *levator veli palatini* and the *tensor veli palatini* (Fig. 107, *c* and *b*). The levator, which is rounded and fleshy, lies posterior to the tensor, which is flat and more tendinous. The tensor can readily be recognised from its position in relation to the deep surface of the internal pterygoid muscle, and because its tendon turns medially under the hamulus of the medial pterygoid lamina. In the upper

PLATE XI

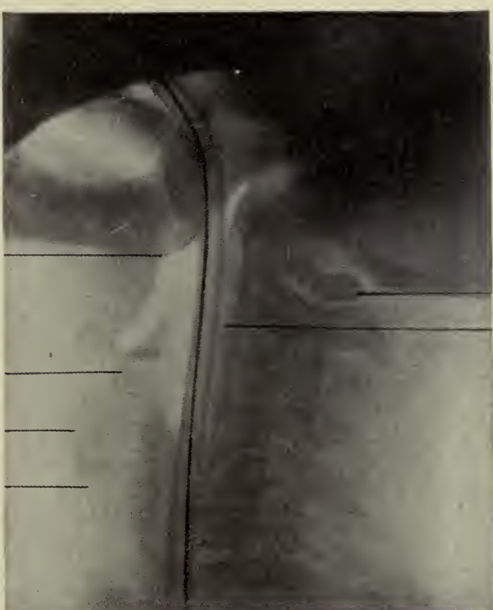


FIG. 108.—Radiograph of Neck, lateral view, showing the position of the pharynx and œsophagus in which a bougie with a metal core had been inserted. (Gouldesbrough.)

PLATE XII

FIG. 109.—Radiograph of Neck, anterior view, showing the position of the œsophagus in which a bougie with a metal core had been inserted. (Gouldesbrough.)

part of the space, close to the base of the skull and between the origin of the two muscles, the *auditory tube* (O.T. *Eustachian tube*) can be defined.

Pharyngeal Aponeurosis.—The upper part of the pharyngeal aponeurosis is strong, and it maintains the integrity of the wall of the pharynx where the muscular fibres of the superior constrictor are absent. As it passes downwards it gradually becomes weaker, until it is ultimately lost as a distinct layer. It lies between the muscles and mucous membrane and is visible, from the outside of the pharynx, only where the muscles are absent. It is the principal means by which the pharynx is attached to the base of the skull, and it is united also to the auditory tubes and the bony margins of the *choanæ*.

Dissection.—**The pharynx must now be opened by a vertical median incision through the entire length of its posterior wall. At the upper extremity of the cut, the knife should be carried transversely, close to the base of the skull. The stuffing must then be removed and the mucous surface of the pharynx cleansed.**

Interior of the Pharynx.—The *mucous membrane* is now exposed, and it should be noted that it is continuous, through the various apertures which open into the pharynx, with the mucous membrane of the *nasal cavities*, the *auditory tubes* and *tympanic cavities*, the *mouth proper*, the *larynx*, and the *œsophagus*.

Racemose glands, which lie immediately subjacent to the mucous membrane and secrete mucus, are present in great numbers. There are also numerous *lymph follicles*, and in certain localities they are aggregated together into large masses (the palatine tonsils and the pharyngeal tonsil), which will be studied with the regions of the pharynx in which they are placed.

The soft palate projects into the pharynx, posterior to the isthmus faucium, and divides the cavity of the pharynx into an upper and a lower part. The *upper part*, called the *naso-pharynx*, communicates with the nasal cavities and the tympanic cavities by four apertures, viz. the two choanæ (O.T. posterior nares) and the two auditory tubes (O.T. Eustachian tubes).

The *lower portion* of the pharynx may be regarded as consisting of an *oral part*, which lies posterior to the mouth and tongue, and a *laryngeal part*, placed posterior to the larynx. Below the soft palate there are three openings into the pharynx, viz. the *opening of the mouth* or *isthmus faucium*, the *opening of the larynx*, and the *opening of the œsophagus.*

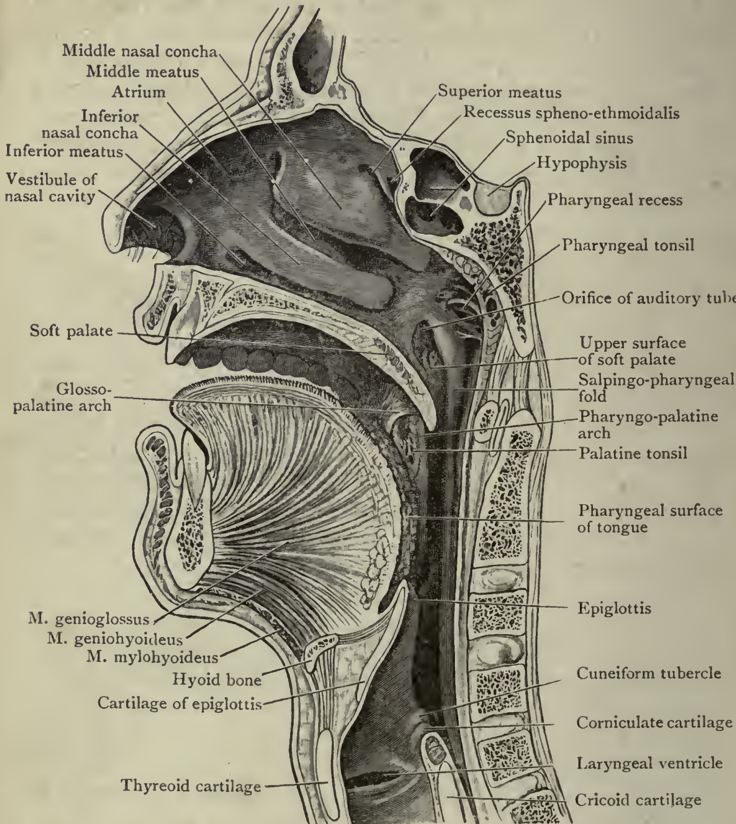


FIG. 110.—Sagittal section, a little to the right of the median plane, through the Nasal Cavity, the Mouth, Pharynx, and Larynx.

Pars Nasalis.—The naso-pharynx is situated immediately posterior to the nasal cavities and below the body of the sphenoid and the basilar part of the occipital bone. It is the widest part of the pharynx. Its walls, except the soft palate, are not capable of movement, and, consequently, its cavity always remains patent, and presents under all conditions very much the same form.

In its *anterior boundary* are the choanæ, through which it opens into the nasal cavities. The *choanæ* are two oblong orifices which slope from the base of the cranium downwards and forwards to the posterior border of the hard palate. Each is about 25 mm. (one inch) long and 12.5 mm. (half an inch) wide, and it is separated from its fellow by the posterior part of the septum nasi, which is formed by the posterior border of the vomer. By looking through the choanæ the dissector will obtain a partial view of the lower two meatuses of the nose and of the posterior ends of the middle and inferior conchæ.

On each *side wall* of the naso-pharynx is seen the orifice of the corresponding auditory tube, and posterior to it the pharyngeal recess. The *pharyngeal orifice* of the auditory tube lies immediately posterior to the lower part of the corresponding choana, on a level with the posterior end of the inferior concha of the same side. It is bounded above and posteriorly by a prominent and rounded margin termed the *torus tubarius*, which is altogether deficient below and anteriorly. A fold of mucous membrane, termed the *salpingo-pharyngeal fold*, descends, upon the side wall of the pharynx, from the posterior lip of the orifice of the auditory tube. As the fold is traced downwards it gradually disappears.

The dissector should pass a Eustachian catheter through the nose into the auditory tube. Hold the catheter with the point downwards. Pass it backwards through the right nasal cavity, along the septum of the nose, to the posterior wall of the pharynx. Pull it towards the palate till the bent end of the catheter catches against the back of the hard palate. Turn the point through a quarter of a circle to the right side of the head and it will enter the right auditory tube. If it is desired to catheterise the left auditory tube pass the catheter through the left nasal cavity, and in the final stage turn the point to the left side.

In the natural condition of parts there is a deep recess on the side wall of the naso-pharynx immediately posterior to the prominent posterior lip of the orifice of the auditory tube. It is termed the *pharyngeal recess*.

The *roof* and *posterior wall* of the naso-pharynx are not marked off from one another. They form together a continuous curved surface. The upper portion of the surface looks downwards and may be regarded as the roof; the lower portion, which looks forwards, constitutes the posterior wall. The *roof* is formed by the basilar part of the occipital bone, and also by a small part of the under surface of the basi-sphenoid, both of which are covered with a dense periosteum and a thick coating of mucous membrane. The *posterior wall* is supported, *posteriorly*, by the anterior arch of the atlas and the anterior surface of the epistropheus. In that part of the roof which lies between the two pharyngeal recesses there is a marked collection of lymphoid tissue, called the *pharyngeal tonsil.* Over its surface the mucous membrane is thickened and wrinkled, and in its lower part a small median pit, termed the *pharyngeal bursa*, may sometimes be found; the bursa is just large enough to admit the point of a fine probe.

The *floor* of the naso-pharynx is formed by the curved, sloping upper surface of the soft palate. Between the posterior border of the soft palate and the posterior wall of the pharynx there is an interval, termed the *naso-pharyngeal isthmus*, through which the naso-pharynx communicates with the oral pharynx.

It is important to note that the posterior wall and roof of the naso-pharynx can be explored by the finger introduced through the mouth and the naso-pharyngeal isthmus.

When the naso-pharynx is illuminated, by light reflected from a mirror introduced through the mouth, a view of the four orifices which open into the nasal part of the pharynx may be obtained. Owing to the mirror being placed obliquely, and below the level of the hard palate, only the posterior parts of the inferior conchæ are visible through the choanæ, and the inferior meatuses of the nose are altogether out of sight. The middle and superior meatuses of the nose and the middle and superior conchæ, however, can be brought into view and their condition ascertained. The lateral walls of the naso-pharynx and the orifices of the auditory tubes also can be fully inspected.

Pars Oralis.—The oral pharynx lies posterior to the mouth and tongue. The *anterior wall* of its lower part is formed by the base or pharyngeal part of the tongue, which looks more or less directly backwards. Above the tongue is the isthmus of the fauces, or the opening into the mouth, limited on each side by the glosso-palatine arch. The glosso-palatine arches may be regarded, therefore, as the lateral boundary lines between the mouth and the pharynx. On the *side wall* of the oral pharynx the pharyngo-palatine arch forms a prominent fold which gradually disappears as it passes backwards and downwards. Within the fold is the pharyngo-palatine muscle, which is of importance because the posterior palatine arches form the boundaries of the naso-pharyngeal isthmus, on each side, and by the contraction of the pharyngo-palatine muscles the two pharyngo-palatine arches can be approximated until the opening of the isthmus is obliterated; the passage of food and fluids from the oral pharynx into the naso-pharynx is thus prevented.

The glosso-palatine arch and the pharyngo-palatine arch form, on each side-wall of the oral pharynx, the anterior and posterior limits of a triangular interval in which is lodged the palatine tonsil. The upper part of the interval, above the level of the tonsil, forms a small depression termed the *supra-tonsillar fossa.*

In the child, and not uncommonly in the adult, a triangular fold of mucous membrane, called the *plica triangularis*, extends backwards from the lower part of the glosso-palatine arch and the base of the tongue across the surface of the palatine tonsil. The upper border of the fold may be free or it may become attached to a greater or less extent to the surface of the tonsil.

Pars Laryngea.—The laryngeal portion of the pharyngeal cavity diminishes rapidly in width to the level at which it becomes continuous with the œsophagus. In its anterior wall, from above downwards, may be seen: (1) the epiglottis; (2) the superior aperture of the larynx, with a recessus piriformis on each side; and (3) the posterior surfaces of the arytænoid and cricoid cartilages, covered with muscles and mucous membrane.

Aditus Laryngis.—The *superior aperture of the larynx*, situated below the pharyngeal part of the tongue, is a large, obliquely placed opening which slopes rapidly from above downwards and backwards. It is somewhat triangular in outline. The basal part of the opening, placed above and anteriorly, is formed by the free border of the epiglottis. Posteriorly, the opening rapidly narrows, and it ends in the interval between the two arytænoid cartilages. The sides of the aperture are formed by two sharp and prominent folds of mucous membrane, termed the *ary-epiglottic folds*, which connect the right and left margins of the epiglottis with the corresponding arytænoid cartilages. Two small nodules of cartilage, in the posterior part of each ary-epiglottic fold, produce two rounded eminences, of which the anterior is the *cuneiform tubercle*, and the posterior is the *corniculate tubercle.*

On each side of the lower part of the laryngeal opening there is a small three-sided or pyramidal depression, called the *recessus piriformis.* On the lateral side each piriform recess is bounded by the posterior part of the corresponding lamina of the thyreoid cartilage and the corresponding part of the thyreo-hyoid membrane; on the medial side, by the arytænoid

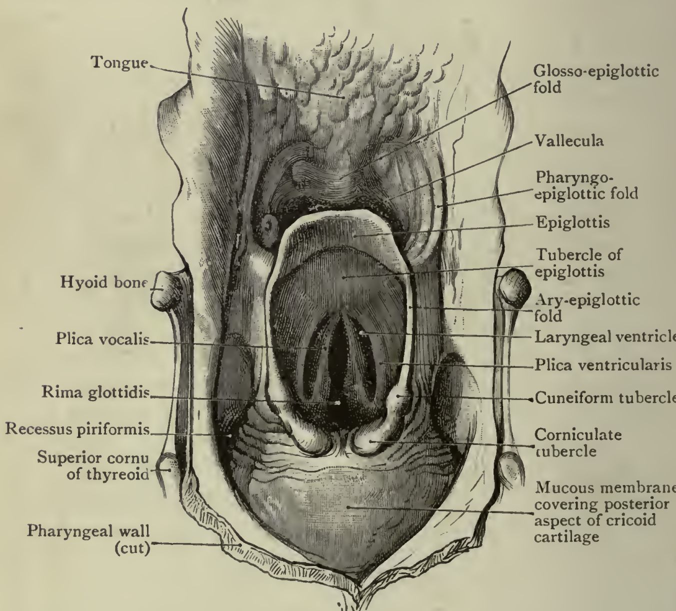


FIG. 111.—Superior Aperture of Larynx exposed by cutting through the posterior wall of the pharynx.

cartilage and the ary-epiglottic fold; whilst its posterior wall is formed by the posterior wall of the pharynx, when that is in place. The piriform recess has a wide entrance, which looks upwards; but it rapidly narrows towards the bottom (Figs. 111 and 112). It is of practical importance because sharp-pointed bodies introduced into the pharynx are liable to be caught in the walls of the sinus.

Below the level of the opening of the larynx, the anterior and posterior walls of the pharynx are always closely applied to each other, except during the passage of food.

The *œsophageal opening* is placed opposite the lower border of the cricoid cartilage, at the narrowest part of the pharynx.

Velum Palatinum.—The soft palate is a movable curtain, which projects downwards and backwards into the pharynx. During deglutition it is raised, and helps to shut off the nasal part of the pharynx from the portion below. *Anteriorly*, it is attached to the posterior margin of the hard palate; *on each side* it is connected with the side wall of the pharynx; whilst *posteriorly* it presents a free border. From the centre

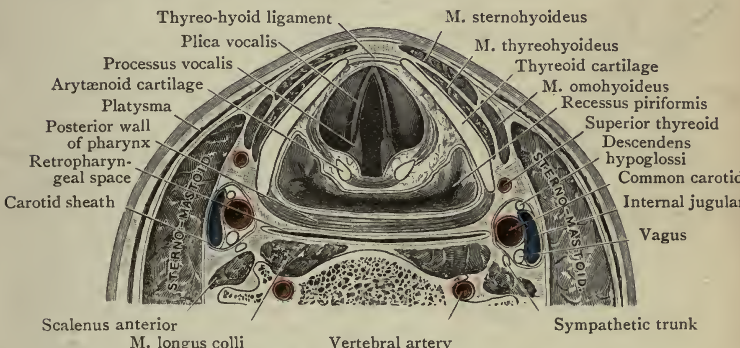


FIG. 112.—Transverse section through the Neck at the level of upper part of the Thyreoid Cartilage.

of the free margin the conical process, termed the *uvula*, projects; whilst the sharp concave part of the border, on each side of the uvula, becomes continuous with the pharyngopalatine arch, which descends on the side-wall of the pharynx. The *upper surface* of the soft palate is convex and continuous with the floor of the nasal cavities. The *inferior surface* is concave and forms part of the vaulted roof of the mouth and the roofs of the supra-tonsillar recesses. From the posterior part of the inferior surface, on each side, a glossopalatine arch curves downwards; and along its median plane may be seen a slightly marked median ridge or raphe.

The soft palate is composed of a fold of mucous membrane, between the two layers of which are interposed muscular, aponeurotic, and glandular structures, together with blood vessels and nerves.

Palatal muscles, . {
The two levatores veli palatini.
The two tensores veli palatini.
The two glosso-palatini.
The two pharyngo-palatini.
The musculi uvulæ.

Palatal aponeurosis.
Palatal glands.

Arteries, . {
Ascending palatine, from external maxillary.
Palatine branch from ascending pharyngeal.
Twigs from the descending palatine branch of the internal maxillary.

Nerves, . {
Middle palatine, Posterior palatine, } from the spheno-palatine ganglion.
Branches from pharyngeal plexus.

The *racemose mucous glands* in the soft palate form a very thick layer, immediately subjacent to the mucous membrane which clothes its inferior surface. Close to the posterior border of the hard palate the soft palate contains very few muscular fibres; and in that situation it is composed chiefly of the two layers of mucous membrane enclosing the glands and the palatal aponeurosis.

Dissection.—The dissection of the soft palate is difficult, and it is only in a fresh part that the precise relations of the different muscular layers can be made out. Begin by rendering it tense by means of a hook, and then carefully remove the mucous membrane from its upper and lower surfaces, and also from the glosso- and pharyngo-palatine arches. The latter proceeding will expose the glosso-palatine and the pharyngo-palatine muscles, on each side.

Musculi Glosso-palatini.—The glosso-palatini are delicate muscular slips, each of which arises from the side of the posterior part of the tongue, whence it curves upwards and medially to reach the under surface of the soft palate, above the glandular layer. There its fibres spread out and become continuous with the corresponding muscular fasciculi of the opposite side. It forms the lowest muscular stratum of the soft palate. The nerve supply is derived from the accessory nerve. When the glosso-palatini muscles contract the glosso-palatine arches are approximated in the median plane, and the cavity of the mouth is shut off from the cavity of the pharynx.

Musculi Pharyngo-palatini.—In the soft palate each pharyngo-palatine muscle consists of two strata, an upper and a lower, between which are enclosed the corresponding muscle of the uvula and the levator of the soft palate.

The *upper layer* is very weak and confined to the posterior part of the velum. It constitutes the most superficial muscular stratum on the upper aspect of the soft palate, and becomes continuous with the corresponding portion of the muscle of the opposite side. The *deeper layer* takes origin from the posterior margin of the palate bone and from the palatal aponeurosis, and some of its fibres mingle with those of the corresponding muscle of the opposite side. Lateral to the soft palate the two strata blend, and are joined by one or two delicate muscular slips which spring from the lower border of the cartilage of the auditory tube. Those slips are sometimes described as the *salpingo-pharyngeus muscle.* The three parts blend at the postero-lateral border of the soft palate, and from there the pharyngo-palatinus passes downwards and backwards in the pharyngo-palatine arch, and spreads out into a thin sheet of fibres in the wall of the pharynx. The pharyngo-palatinus blends, to some extent, with the stylo-pharyngeus, and is inserted, with the stylo-pharyngeus, into the posterior border of the thyreoid cartilage. Some of its fibres, however, incline backwards and are inserted into the pharyngeal aponeurosis. It helps to close the isthmus of the pharynx and to elevate the larynx; it is supplied by the accessory nerve.

Musculi Uvulæ.—The two small muscles of the uvula, right and left, lie in the upper part of the soft palate, covered on their upper surfaces by the upper parts of the pharyngo-palatine muscles, which must be removed before the muscles of the uvula can be seen. Each muscle of the uvula is a minute slip which springs from the posterior nasal spine. As they pass backwards the two slips blend, and their fibres are inserted into the mucous membrane of the uvula. They are supplied by the accessory nerve, and when they contract they elevate the uvula.

Dissection.—The levator veli palatini muscle has been seen already, on the outer aspect of the pharynx, in the sinus of Morgagni (Fig. 107). To display it from the inside it is necessary to remove the mucous membrane, the submucous tissue, and the membranous part of the wall of the pharynx between the auditory tube, above, and the upper border of the superior constrictor, below; afterwards the fibres of the muscle must be followed into the soft palate where it lies between the two layers of the pharyngo-palatine muscle. In a well-injected subject the dissector

will note the terminal part of the ascending palatine branch of the external maxillary artery descending along the levator palati into the soft palate.

Musculi Levatores Veli Palatini.—Each elevator muscle of the soft palate is a rounded, fleshy muscle which arises from the lower and medial border of the cartilage of the corresponding auditory tube, and from the rough surface on the under aspect of the apex of the petrous part of the adjacent temporal bone. It passes downwards and forwards, crosses the upper border of the superior constrictor, pierces the pharyngeal aponeurosis, passes below the orifice of the auditory tube, and enters the soft palate. There its fibres spread out below the uvular muscle and above the anterior or deep portion of the pharyngo-palatinus. Anteriorly, some of the fibres are inserted into the palatal aponeurosis; but more posteriorly, the majority of the fibres become continuous with the corresponding fasciculi of the opposite side. The nerve supply is derived from the accessory nerve. The name of the muscle indicates its action.

Musculi Tensores Veli Palatini.—The origin of each tensor muscle of the soft palate and the relations of its muscular belly were noted on p. 200. The muscle descends from the scaphoid fossa of the base of the skull along the lateral surface of the medial pterygoid lamina, and it ends in a tendon which turns horizontally towards the median plane, below the hamulus, where a bursa mucosa facilitates the play of the tendon on the bone. In the soft palate the tendon expands below the lower layer of the pharyngo-palatinus, and some of its fibres blend with the palatal aponeurosis, whilst others gain attachment to the horizontal part of the palate bone. It is supplied by the mandibular division of the trigeminal nerve. Its name indicates its action.

Palatal Aponeurosis.—The palatal aponeurosis extends backwards from the posterior margin of the hard palate, to give strength and support to the soft palate. At first it is strongly marked, but it weakens rapidly as it passes posteriorly. The small portion of the soft palate which it supports contains few muscular fibres, and remains always more or less horizontal in position. The much more extensive posterior muscular part of the soft palate constitutes the movable sloping portion. The tensor of the soft palate operates upon the anterior aponeurotic portion of the soft palate.

Vessels and Nerves of the Soft Palate.—The *ascending palatine branch* of the external maxillary artery is, as a rule, the principal artery of supply to the soft palate. It has already been traced on the wall of the pharynx (pp. 205 and 210), where it lies in the sinus of Morgagni, in relation to the levator veli palatini muscle, which it accompanies into the soft palate. The *palatine branch* of the ascending pharyngeal artery may also be traced into the soft palate; in cases where the ascending palatine artery is small, this twig becomes enlarged and takes its place (p. 210). The *descending palatine branch* of the internal maxillary artery also sends small twigs to the soft palate and palatine tonsil.

Two nerves enter the soft palate from the spheno-palatine ganglion—viz., the *posterior palatine* and the *middle palatine nerve.* It would appear, however, that they do not supply the muscles, but are distributed to the mucous membrane. The levator veli palatini, the musculus uvulæ, the glosso-palatinus, and the pharyngo-palatinus are supplied by twigs from the pharyngeal branches of the vagus, which convey to the muscles fibres which are originally derived from the cerebral part of the accessory nerve (*v.* p. 223) (W. Aldren Turner). The tensor veli palatini is probably supplied by the branch which it receives from the otic ganglion, which conveys to it fibres originally derived from the motor part of the mandibular division of the trigeminal nerve.

Tonsillæ Palatinæ.—The palatine tonsils are two prominent masses of lymphoid tissue, placed one in each side wall of the pharynx, in the triangular interval between the two palatine arches and immediately above the pharyngeal part of the tongue. The *pharyngeal* or *medial surface* of the tonsil is covered with mucous membrane and presents a number of orifices which lead into crypts or recesses in its substance. The *deep* or *lateral surface* is embedded in the pharyngeal wall and is supported by the superior constrictor muscle of the pharynx (see p. 205). It is covered by a layer of fibrous tissue which forms an incomplete capsule for the organ. It is important to note that between the palatine tonsil and the superior constrictor there is some lax connective tissue, so that the tonsil can be pulled forwards by the vol-sellum without dragging the wall of the pharynx with it.

Each palatine tonsil has a rich *blood-supply*. It derives arterial twigs from the tonsillar and ascending palatine branches of the external maxillary, the descending palatine branch of the internal maxillary, the ascending pharyngeal, and the dorsalis linguæ of the corresponding side.

The dissectors should note that the tonsil lies at about the level of the angle of the mandible, and that the wall of the pharynx separates it from the external maxillary artery. The internal and external carotid arteries also lie lateral to the region of the tonsil, but they are further away than the external maxillary.

Tuba Auditiva (O.T. **Eustachian Tube**).—The auditory tube is the canal which conveys air from the pharynx to the tympanic cavity. It is about 25 mm. long and is divided into two portions, according to the parts which enter into the construction of its wall. In the *lateral part* of its course, as it nears the tympanic cavity, its walls are bony, and it runs in the interval between the tympanic and petrous portions of the temporal bone. The *medial part* consists mainly of cartilage. It is placed on the base of the skull, and is lodged in the gutter or groove between the petrous part of the temporal bone and the great wing of the sphenoid. The cartilaginous part of the tube comes under the notice of the dissector at the present stage, and he should first note its direction and then study its relations and the construction of its wall.

The dissector can readily ascertain the direction of the canal by passing a probe into it through its pharyngeal orifice. It runs backwards and laterally, with a slight inclination upwards, and passes first above and then to the lateral side of the elevator muscle of the soft palate, and along the medial side of the upper part of the tensor of the soft palate. It lies, therefore, in a considerable part of its extent, between the two muscles (Fig. 218).

Before removing the mucous membrane from the pharyngeal part of the tube, the dissector should note that at the lower margin of the orifice there is a prominent rounded eminence, the *levator cushion*, due to the subjacent elevator muscle of the soft palate. The removal of the mucous membrane will reveal the fact that the wall of the tube is formed, in great part, by a triangular plate of cartilage, which is folded upon itself so as to protect the tube on its upper and medial aspects. The cartilage is deficient below and laterally, its place being taken by dense fibrous tissue, which connects the margins of the cartilage and completes the wall of the canal. The projecting free base of the cartilage gives rise to the torus tubarius, already examined, on the side wall of the naso-pharynx (p. 289). A muscular slip, which descends from the lateral margin of the cartilage, in relation to the lateral, unprotected side of the tube, has been termed the *dilatator tubæ* (Rudinger). It joins the tensor of the soft palate. The interior of the tube is lined with mucous membrane continuous with that of the pharynx and the tympanic cavity; and its calibre varies considerably in different parts of its course. It is narrowest at a point termed the *isthmus*, situated at the junction of the osseous and cartilaginous parts. As the tube is traced from the isthmus to the pharynx it gradually increases in calibre, and it attains its greatest width at its pharyngeal aperture.

CAROTID CANAL.

The carotid canal, which traverses the petrous part of the temporal bone, contains the internal carotid artery, the internal carotid continuation of the cervical part of the sympathetic trunk, and a plexus of veins.

***Dissection.*—To open up the carotid canal, remove its inferior wall with the bone forceps ; but do not interfere with the auditory tube, which lies in close proximity. The dissection must be made on one side only.**

Arteria Carotis Interna.—The portion of the internal carotid artery which passes through the carotid canal in the petrous part of the temporal bone is about 18 mm. (three-quarters of an inch) long. At first it ascends vertically; then, bending suddenly, it runs horizontally and forwards. It emerges from the canal at the apex of the petrous bone and enters the foramen lacerum, where it turns upwards, pierces the external layer of the dura mater, and enters the middle fossa of the skull. The remainder of the course of the internal carotid artery has been examined already (p. 239). Within the carotid canal it lies below and anterior to the cochlea and the tympanic cavity. The greater superficial petrosal nerve and the semilunar ganglion are placed above it, but are separated from it by a thin plate of bone, which, however, may be replaced by fibrous tissue.

Nervus Caroticus Internus.—The dissector has already noted that the internal carotid nerve is a large branch which proceeds from the upper end of the superior cervical ganglion, and enters the carotid canal, with the internal carotid artery. It divides almost immediately into two parts, which are placed one on each side of the artery. Each part soon divides into a number of branches which communicate together, around the internal carotid artery, forming the *internal carotid plexus*. The dissection of the branches is a matter of some difficulty, and can be satisfactorily effected only under specially favourable circumstances.

At the posterior end of the cavernous sinus a ganglion is sometimes found in the plexus, and where the sixth nerve crosses the internal carotid artery the plexus is very dense. That part is known as the *cavernous plexus*. At the anterior end of the cavernous sinus the carotid plexus breaks up into branches which accompany the anterior and middle cerebral arteries.

The internal carotid plexus communicates with the tympanic plexus by means of superior and inferior carotico-tympanic branches given off in the carotid canal, and with the spheno-palatine ganglion by the great deep petrosal branch, which unites with the greater superficial petrosal of the facial nerve to form the nerve of the pterygoid canal (O.T. Vidian). It gives branches also to the semilunar ganglion, the third, fourth, sixth and the ophthalmic branch of the fifth nerve, and a branch which accompanies the naso-ciliary nerve into the orbit, where it joins the ciliary ganglion.

NERVUS MAXILLARIS.

As the maxillary nerve passes forwards, from the semilunar ganglion to the face, it traverses the foramen rotundum, the upper part of the pterygo-palatine fossa, the pterygo-maxillary fissure, the infra-temporal fossa, the inferior orbital fissure, and the infra-orbital canal. The dissector should therefore proceed to expose the nerve in those localities.

Dissection.—Remove the temporal muscle and the upper head of the external pterygoid muscle, and, placing the saw upon the cut margin of the skull at a point immediately above the external meatus, carry it obliquely downwards and forwards, through the squamous part of the temporal bone and the great wing of the sphenoid, towards the medial end of the superior orbital fissure. This saw-cut should enter the superior orbital fissure immediately to the lateral side of the foramen rotundum. A second saw-cut should then be made from the cut margin of the cranial wall, immediately above the anterior margin of the great wing of the sphenoid bone, downwards into the superior orbital fissure to meet the first saw-cut. The wedge-shaped piece of bone included between the cuts can now be removed. To obtain additional space, and to open up the pterygo-palatine fossa more fully, remove what remains of the great wing of the

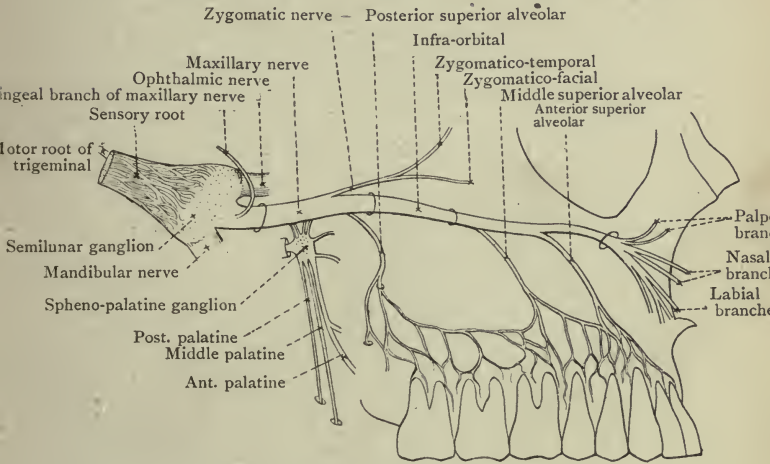


FIG. 113.—Diagram of the Maxillary Nerve.

sphenoid upon the lateral side of the foramen rotundum, but the circumference of that aperture must be carefully preserved. Proceed, in the next place, to open up the infra-orbital canal. In its posterior part its upper wall is usually so thin that it can easily be removed by a pair of dissecting forceps, but more anteriorly the canal sinks deeply under the lower part of the rim of the orbital opening, and there the chisel must be employed. The maxillary nerve can now be defined and its branches displayed. The infra-orbital artery and vein, which accompany the nerve in the infra-orbital canal, will be exposed at the same time.

Nervus Maxillaris.—The maxillary nerve springs from the semilunar ganglion, within the cranial cavity (Fig. 113). It is composed entirely of sensory fibres, and passes forwards, outside the dura mater and in relation to the lower part of the cavernous sinus, to the foramen rotundum, through which it enters the pterygo-palatine fossa. It crosses the upper part of that fossa, curves laterally through the pterygo-maxillary fissure into the infra-temporal fossa, and, near the middle of the inferior orbital fissure, enters the infra-orbital canal, where it receives the name of *infra-orbital.* The infra-orbital canal traverses the floor of the orbit, which, it should be remembered, forms the roof of the maxillary sinus also. Finally, leaving the infra-orbital canal, the nerve emerges upon the face through the infra-orbital foramen, and breaks up, under cover of the quadratus labii superioris, into numerous branches which unite with twigs from the facial nerve to form a dense plexus. Its terminal filaments are distributed to the lower eyelid, the nose, and the upper lip. The course of the maxillary nerve may be separated into five stages, in each of which branches are given off. These are:—

1. Within the cranium, .	Meningeal (p. 238).
2. In the pterygo-palatine fossa, . .	Spheno-palatine.
3. In the infra-temporal fossa, . . .	Zygomatic (already described, p. 261). Posterior superior alveolar.
4. In the infra-orbital canal, . . .	Middle superior alveolar. Anterior superior alveolar.
5. In the face, . .	Palpebral, Nasal, Labial, already described: (p. 15).

The *spheno-palatine branches* are two stout twigs which arise from the inferior aspect of the maxillary nerve, and proceed vertically downwards, in the pterygo-palatine fossa, to the spheno-palatine ganglion, of which they constitute the *sensory roots.*

The *zygomatic nerve*, which has already been dissected in the orbit, can now be traced to its origin from the maxillary nerve in the infra-temporal fossa.

Nervi Alveolares Superiores.—There are usually three superior alveolar nerves which are distinguished as posterior, middle, and anterior. The middle superior alveolar nerve is sometimes absent as a separate trunk, in which case its fibres arise in common with the anterior superior alveolar branch.

The *posterior superior alveolar nerve* takes origin in the infra-temporal fossa, and almost immediately divides into two branches, which proceed downwards upon the posterior aspect of the body of the maxilla. They contribute a few fine filaments to the mucous membrane of the cheek and to the gum, and then disappear into the minute posterior alveolar foramina to supply the three molar teeth and the lining membrane of the maxillary sinus.

The *middle superior alveolar nerve* supplies the two premolar teeth. It arises from the infra-orbital nerve, and can be easily detected (if present as a separate branch) when the parent trunk is gently raised from the floor of the infra-orbital canal. It descends in a minute canal which traverses the lateral wall of the maxillary sinus.

The *anterior superior alveolar nerve*, much the largest of the three alveolar branches, springs from the infra-orbital as it approaches the anterior part of the canal. To bring it into view raise the parent trunk from the floor of the canal, and the branch will then be seen to enter a special bony tunnel which traverses the maxilla in the anterior wall of the maxillary sinus. The dissector should endeavour to open up that canal with the chisel. After supplying a branch to the mucous membrane of the lower and anterior part of the nasal cavity, the anterior superior alveolar nerve divides into branches for the incisor and the canine teeth.

While traversing the maxilla, the three superior alveolar branches communicate with one another, and form two nerve loops (Fig. 113). Numerous twigs proceed from both loops, and they communicate with one another to form a fine plexus. It is from that plexus that the terminal filaments to the teeth and gums take origin.

Arteria Infraorbitalis.—The infra-orbital artery is a branch of the internal maxillary. It arises in the pterygo-palatine fossa and accompanies the infra-orbital nerve. In the face its terminal twigs anastomose with branches of the external maxillary, transverse facial, and buccinator arteries; in the infra-orbital canal it gives some fine branches to the contents of the orbital cavity, and also the *anterior superior alveolar artery* which accompanies the nerve of that name, and supplies the incisor and canine teeth, and the lining membrane of the maxillary sinus.

The *infra-orbital vein* joins the pterygoid plexus.

NASAL CAVITIES.

Dissection.—The portion of the mandible which still remains, together with the tongue and larynx, must now be removed from the upper part of the skull. From the angle of the mouth, on each side, carry the knife backwards, through the buccinator and the mucous membrane of the cheek, and through the pterygo-mandibular raphe and the side wall of the pharynx. The internal pterygoid muscle has been divided already, but it will be necessary to cut the internal carotid artery, the smaller vessels which are still undivided and the nerves which still connect the pharynx with the skull. The larynx and tongue must be laid aside for future dissection.

The anterior part of the skull should next be divided into two parts by sawing through it, in the sagittal direction, close to one side of the nasal septum. As a general rule the nasal septum is not vertical, but deviates more or less to one or other side of the median plane. The deviation is more frequently to the right than to the left side. Endeavour to determine the direction which it takes in the skull under observation by passing a probe into the nasal cavity through the choanæ. The section through the skull should be made close to the concave side of the septum. Begin anteriorly by introducing a knife into the nostril of that side, and carry it upwards through the cartilaginous part of the nose to the nasal bone. Then place the specimen so that the face rests upon the table, and divide the soft palate in the median plane. The section may now be completed by sawing through the hard palate and bony roof of the nasal cavity at the side of the median plane. The dissector should make every effort to preserve the septum of the nose intact. As a general rule the upper concha is partially injured. That is not a very serious matter, as the lateral aspect of the nasal cavity can be studied upon the opposite side when the septum of the nose has been removed.

Septum Nasi.—The nasal septum divides the cavity of the nose into two narrow chambers—the right and left nasal cavities. It is not placed accurately in the median plane, but almost invariably shows a bulging or deviation to one or other side (more frequently to the right side). Immediately above the orifice of the nostril or anterior aperture of the nasal cavity, the septum shows a slight depression which corresponds to the *vestibule* of the nose, and forms the medial wall of that subdivision of the nasal cavity. The vestibular part of the partition is clothed with skin, continuous with the external integument; a number of stiff hairs, termed *vibrissæ*, project from the skin into the cavity. Over the rest of its extent the septum nasi is covered with mucous membrane, which is closely adherent to the subjacent periosteum forming with it a *muco-periosteum*; and it is separable into two districts, viz., a lower or *respiratory area*, and a much smaller upper or *olfactory area*, comprising not more than the upper third of the septum, in which branches of the olfactory nerve spread out. The respiratory mucous membrane is very thick and spongy. It is highly vascular and contains numerous mucous glands. The minute orifices of the gland ducts can be detected by the naked eye. Over the olfactory district of the septum the mucous

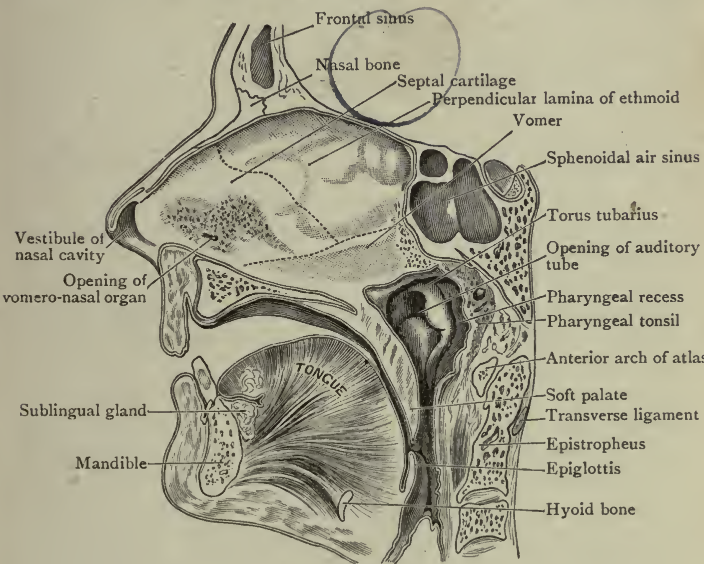


FIG. 114.—Antero-posterior section through the Nose, Mouth, and Pharynx, a little to the left of the median plane.

membrane is softer and more delicate, and not so thick. In the fresh state it presents a yellowish colour, and the glands are smaller.

In favourable cases a minute orifice may be detected in the mucous membrane on the lower and anterior part of the nasal septum, immediately posterior to the vestibular area. It is placed above the anterior end of a well-marked elongated projection which passes obliquely backwards and upwards, and corresponds to the thickened lower margin of the septal cartilage. The aperture varies in diameter from $\frac{1}{2}$ mm. to $1\frac{1}{2}$ mm. (Schwalbe). It leads into a narrow canal, which passes backwards for a short distance, and then ends blindly. It is of interest because it represents in the human subject the rudiment of the *vomero-nasal organ*

(O.T. *organ of Jacobson*), a tubular structure which is highly developed in some of the lower animals.

Construction of the Nasal Septum.—Strip the muco-periosteum from the exposed surface of the septum nasi, and the parts forming the septum will be rendered visible. The bulk of the partition is composed of the vomer and the perpendicular lamina of the ethmoid posteriorly, and of the septal cartilage anteriorly. Small portions of other bones take a minor part in its construction. Thus, above and posteriorly there are the crest and rostrum of the sphenoid; above and anteriorly are the nasal spine of the frontal bone and the crest of the nasal bones; whilst below there is the crest of bone formed by the apposition of the palatal processes of the palate and maxillary bones of opposite sides.

Cartilago Septi Nasi.—The septal cartilage fills up the wide angular gap which intervenes between the vomer and the perpendicular lamina of the ethmoid, and it projects forwards towards the point of the nose. It is a broad irregularly quadrilateral plate. Its *upper and posterior border* is in apposition with the anterior border of the perpendicular lamina of the ethmoid; *its lower and posterior border*, much thickened, is received into the groove in the anterior border of the vomer and the nasal crest of the maxillæ. The angle between the two borders mentioned is prolonged backwards, for a varying distance, in the form of a tongue-shaped cartilaginous process, which occupies the interval between the two plates of the vomer. The *upper and anterior border* of the septal cartilage is in contact, above, with the suture between the two nasal bones; below that, it is related to the two lateral cartilages of the nose, whilst still lower down it occupies the interval between the medial parts of the two larger alar cartilages.

Its connection with the lateral cartilage on each side is a very intimate one; indeed, below the nasal bones, the three cartilages are directly continuous, but lower down they are separated by a fissure which runs upwards for some distance on each side. The *lower and anterior border* is very short; it is free, and extends backwards to the anterior nasal spine. The anterior angle of the septal cartilage is blunt and rounded, and does not reach to the point of the nose, which is formed by the alar cartilages.

The deviation of the septum nasi from the median plane will now (in all probability) be seen to be due to a bulging of the vomer and perpendicular lamina of the ethmoid to one side, along their line of union. It is not developed until after the seventh year.

Dissection.—The septal cartilage and thin bony part of the septum must now be removed piecemeal. The removal must be done very carefully, in order to preserve intact the muco-periosteum which clothes the opposite side of the septum. It is in that muco-periosteum that the nerves and blood-vessels must be examined.

Vessels and Nerves of the Septum Nasi.—The following is a list of the nerves:—

Nerves of Smell, .	Olfactory.
Nerves of Common Sensation, . .	1. Naso-palatine. 2. Medial nasal branch of the anterior ethmoidal nerve. 3. Nasal branches from spheno-palatine ganglion and from the nerve of the pterygoid canal (O.T. Vidian).

The Medial Group of Olfactory Nerves.—The medial group of olfactory nerves is associated with the muco-periosteum of the upper part of the nasal septum and the various nerve filaments are barely distinguishable, except in a fresh part; further, they are so soft that it is hardly possible to isolate them. They proceed upwards in grooves on the surface of the perpendicular lamina of the ethmoid, and leave the nasal cavity through the medial series of apertures in the cribriform plate of the same bone.

Nervus Naso-palatinus.—The naso-palatine nerve is a long slender twig which can easily be detected upon the deep surface of the muco-periosteum of the septum. It springs from spheno-palatine ganglion, and enters the nasal cavity through the spheno-palatine foramen. In the first part of its course it runs medially, upon the inferior surface of the body of the sphenoid. Having gained the nasal septum, it changes its direction and passes downwards and forwards, in a shallow groove on the surface of the vomer, under cover of the muco-periosteum. Finally, it enters the foramen of Scarpa, and, where the two foramina of Scarpa open into the common incisive foramen, the nerves of opposite sides unite in a plexus from which branches are given to the mucous membrane covering the anterior part of the hard palate. The naso-palatine nerve is accompanied by the posterior nasal septal artery; and, as it lies on the surface of the vomer, it supplies some small twigs to the muco-periosteum of the septum nasi.

A few *nasal branches* from the *spheno-palatine ganglion*, and also from the *nerve of the pterygoid canal*, reach the muco-periosteum over the superior and posterior part of the septum. They are very minute, and it is questionable if the dissector will be able to discover any trace of them in an ordinary part.

The *medial nasal branches of the anterior ethmoidal nerve* will be found descending over the anterior part of the nasal septum. They may be traced as far as the vestibule.

The *arteries* which convey blood to the septum nasi are: (1) the posterior nasal septal branch of the spheno-palatine artery, which accompanies the naso-palatine nerve; (2) a branch of the anterior ethmoidal, accompanying the medial branches of the anterior ethmoidal nerve; (3) some minute twigs, to the upper part of the septum, from the posterior ethmoidal artery; (4) the septal branch of the superior labial artery, which is distributed to the lower and front part of the septum.

Dissection.—Disengage the naso-palatine nerve and the medial branches of the anterior ethmoidal nerve from the surface of the muco-periosteum of the septum, in order that, afterwards, they may be traced to their origins. Then, with scissors, divide the muco-periosteum along the roof ot the nasal cavity and turn it down. When that is done, the opposite nasal cavity will be exposed.

Cava Nasi.—The nasal cavities are two chambers placed one on each side of the septum nasi. They are narrow, but the vertical depth and antero-posterior length of each cavity is very considerable. The width increases somewhat from above downwards; thus, in the upper part, the superior concha is separated from the septum by an interval of only 2 mm., whilst lower down a space of 4 or 5 mm. intervenes between the inferior concha and the septum. Each nasal cavity presents a medial wall formed by the septum, a lateral wall, a roof, a floor, and an anterior and a posterior aperture.

The *anterior apertures* of the nasal cavities, or *nostrils*, are two oval orifices which open upon the face and look downwards. The *posterior apertures*, or *choanæ*, open into the naso-pharynx and look backwards and downwards.

The narrow *roof* of the nasal cavity consists of a *middle*, horizontal portion, formed by the cribriform plate of the ethmoid bone, and of an anterior and a posterior sloping part. The *anterior part* is formed by the narrow grooved nasal surface of the frontal spine of the frontal bone, by the nasal bone, and by the angle between the lateral cartilage and the septal cartilage. The *posterior part* of the roof is composed of the anterior and inferior surfaces of the body of the sphenoid, and also of the ala of the vomer, the sphenoidal process of the palate bone, and the vaginal process of the medial pterygoid lamina, all of which are applied to the inferior surface of the body of the sphenoid.

The *floor* of the nasal cavity is of considerable width. It is formed by the palatal processes of the maxilla and the palate bones, and is concave from side to side. Further, it presents

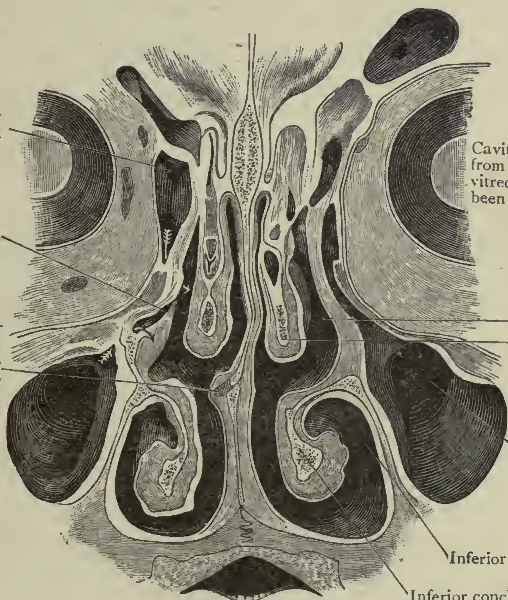


FIG. 115.—Posterior aspect of Frontal section through the Nasal Cavities opposite the Crista Galli of the Ethmoid Bone.

The *upper arrow* shows the opening of an anterior ethmoidal cell into the hiatus semilunaris. The *lower arrow* passes from the maxillary sinus into the hiatus semilunaris.

a gentle antero-posterior slope, being slightly higher anteriorly than posteriorly. On the anterior part of the floor, and close to the septum nasi, the dissector may see a minute funnel-shaped depression of the muco-periosteum leading into the incisive foramen. The depression is of interest from a developmental point of view; for it is a vestige of the extensive communication which existed in the embryo between the cavities of the nose and the mouth.

Lateral Wall of the Nasal Cavity.—The lateral wall of each nasal cavity is rendered uneven by the projection of the three conchæ (O.T. turbinal bones).

The part which the different bones take in the formation of the lateral wall of the cavity of the nose must in the first place be studied in a sagittal section through the macerated skull, and the dissector should constantly refer to such a preparation during the dissection. Anteriorly, it is formed by the lateral cartilage, the alar cartilage, the nasal bone, and the frontal process of the maxilla. More posteriorly the lacrimal, the ethmoid, and the inferior concha, and a portion of the body of the maxilla, enter into its construction; whilst still more posteriorly are the perpendicular part of the palate bone and the medial pterygoid lamina of the sphenoid. Placed in relation to the lateral aspect of the lateral wall are the ethmoidal air-cells, which intervene between the upper part of the nasal cavity and the orbit, whilst, at a lower level, the great air sinus of the maxilla, the *maxillary sinus*, is situated immediately to the lateral side of the nasal cavity (Fig. 115).

Turning now to the dissection, the dissector will see that the lateral wall is separable into three areas or districts. They are—(1) the vestibule; (2) the atrium meatus medii; (3) the region of the conchæ and the intervening meatuses.

Vestibulum Nasi.—The *vestibular part* (Fig. 116, 6, 6′) of the lateral wall is a depression of a somewhat oval form placed immediately above the aperture of the nostril. It is partially divided into an upper and lower portion by a short ridge, which projects forwards from its posterior boundary; and in the whole of its extent it is clothed by ordinary integument. From the skin a number of stout, stiff hairs, termed *vibrissæ*, project (Fig. 116, 5). The vibrissæ which spring from the anterior part of the region incline backwards, whilst those which are implanted into the posterior part are directed forwards; in that manner a sieve-like arrangement is provided at the anterior aperture of the nose. The vestibular part of the lateral wall is placed opposite the corresponding area on the septum nasi, and the two together constitute an ampullated entrance to the nasal cavity. The capacity and shape of the vestibule are influenced to a certain extent by the contraction of the nasal muscles.

Atrium Meatus Medii.—The atrium of the middle meatus of the nasal cavity (Fig. 116, 8) is placed above, and slightly posterior to, the vestibular district, and it receives its name from the fact that it lies immediately anterior to the middle meatus. It is slightly hollowed out and concave, and at its upper part, near the nasal bone, a feeble elevation termed the *agger nasi* may be noticed; the agger nasi begins close to the anterior part of the attached margin of the middle concha, and runs obliquely downwards and forwards. It represents an additional concha which is present in some mammals. A slight depression above the agger nasi, which leads posteriorly to

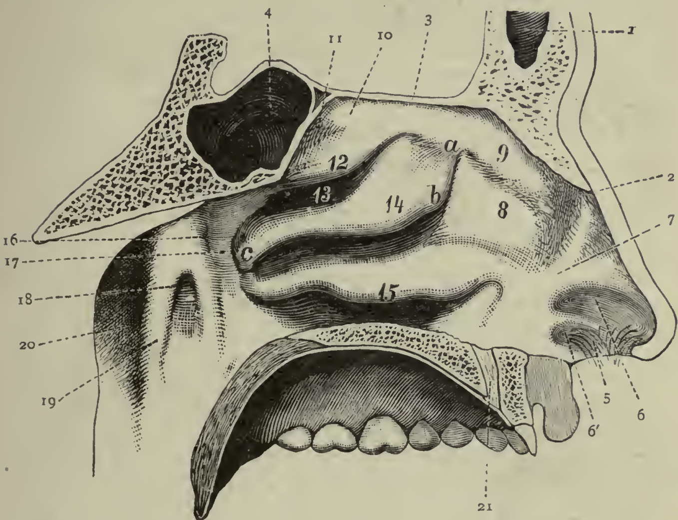


FIG. 116.—Lateral wall of the Left Nasal Cavity. (From Schwalbe.)

1. Frontal air sinus.
2. Free border of the nasal bone.
3. Cribriform plate of ethmoid.
4. Sphenoidal air sinus.
5. Vibrissæ.
6′, 6. The two parts of the vestibular area.
7. Elevation intervening between the vestibular district and the atrium.
8. Atrium meatus medii.
9. Agger nasi, or rudiment of an anterior concha.
10. Concha suprema.
11. Recessus spheno-ethmoidalis.
12. Superior concha.
13. Superior meatus.
14. Middle concha.
15. Inferior concha.
16. Plica naso-pharyngea.
17. Meatus naso-pharyngeus.
18. Orifice of auditory tube.
19. Posterior lip of auditory tube.
20. Pharyngeal recess.
21. Incisive foramen.
a, *b*, *c*. Free border of the middle concha.

the olfactory district of the lateral wall of the nasal cavity, is the *sulcus olfactorius*.

Conchæ (O.T. turbinal bones).—Posterior to the vestibule and the atrium are the conchæ, with the intervening meatuses. The *superior concha* (Fig. 116, 12), which projects from the labyrinth of the ethmoid bone, is very short, and is placed on the upper and posterior part of the lateral wall of the cavity. Its free border begins a little below the centre of the cribriform plate, and passes obliquely downwards and backwards, to a point immediately below the body of the sphenoid, where it ends. The *middle concha* (Fig. 116, 14) also is a part of the ethmoid. Its free border begins a short distance below the anterior end of the cribriform plate, and at first takes a vertical course downwards; then, bending suddenly, it passes backwards, and it ends midway between the body of the sphenoid and the posterior border of the hard palate. The *inferior concha* (Fig. 116, 15) is an independent bone; it extends backwards, upon the lateral wall of the nasal cavity, midway between the middle concha and the floor of the nose. Its lower free margin is somewhat convex downwards.

Meatus Nasi.—The *superior meatus* (Fig. 116, 13) is a short narrow fissure between the superior and middle conchæ. The posterior ethmoidal cells open into its upper and anterior part, by one, or, in some cases, by several apertures.

To bring the apertures into view, turn the superior concha aside, introduce the blade of a pair of forceps under its entire length, and force it upwards. Care should be taken not to injure the mucous membrane more than is necessary.

The *middle meatus* is a much more roomy passage than the superior meatus; it extends backwards from the atrium, between the middle and inferior conchæ. To expose it tilt the middle concha forcibly upwards and backwards.

The upper and anterior part of the middle meatus leads into a funnel-shaped passage which runs upwards into the corresponding frontal sinus. The passage is called the *infundibulum*, and it constitutes the channel of communication between the frontal sinus and the nasal cavity.

Upon the lateral wall of the middle meatus a deep curved groove or gutter, which commences at the infundibulum and runs from above downwards and backwards, will be seen. The groove is termed the *hiatus semilunaris* (Fig. 117), and in it are the openings of the anterior ethmoidal cells and the maxillary sinus. The slit-like opening of the maxillary sinus lies in the posterior part of the hiatus semilunaris. The upper boundary of the hiatus semilunaris is prominent and bulging. It is termed the *bulla ethmoidalis*. On or above the bulla is the aperture of the middle ethmoidal cells (Fig. 117).

Dissection.—Open the maxillary sinus from the lateral side, by sawing upwards through the zygomatic process of the maxilla. Then examine the interior of the sinus.

The orifice by means of which the great maxillary air sinus communicates with the middle meatus lies in the medial wall of the sinus, much nearer the roof than the floor—a position highly unfavourable for the escape of fluids which may collect in the cavity. Sometimes, however, a second orifice,

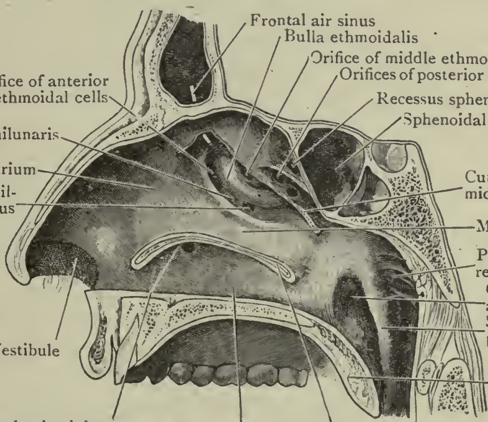


FIG. 117.—Lateral wall of Nasal Cavity and Naso-pharynx. The three conchæ have been removed.

circular in outline, will be found. If it is present it is situated lower down, and it opens into the middle meatus, immediately above the middle point of the attached margin of the inferior concha.

The dissector should note that, on account of the relationship of the infundibulum to the hiatus semilunaris and of the latter to the opening of the maxillary sinus, there is a tendency, in some cases, for the secretion of the frontal sinuses to flow into the maxillary sinus.

The *inferior meatus* is the horizontal passage which lies between the inferior concha and the floor and lateral wall of the nasal cavity. It is placed posterior to the vestibule, and the free border of the inferior concha turns downwards and limits it anteriorly (Fig. 117). On that account, and because its floor slopes downwards and backwards, the inferior meatus is more accessible to the current of expired air than to the current of inspired air. In the anterior part of the inferior meatus will be found the opening of the naso-lacrimal duct, which conveys the tears to the nasal cavity (Fig. 117).

Dissection.—To bring the aperture of the naso-lacrimal canal into view, remove a small portion of the anterior part of the inferior concha with the scissors (Fig. 117).

The orifice of the naso-lacrimal duct varies in form, according to the manner in which the mucous membrane is arranged around it. Sometimes it is wide, patent, and circular; at other times the mucous membrane is prolonged over the opening, reducing its size and acting as a flap valve to the orifice. In some cases, indeed, the orifice may be so minute that it is difficult to find. Its continuity with the lacrimal sac should in all cases be established by passing a probe, from above downwards, through the naso-lacrimal canal (Fig. 9).

The space above and behind the superior concha is termed the *recessus spheno-ethmoidalis*, and in its posterior part is the aperture of the sphenoidal air sinus (Fig. 117). The orifice of the sphenoidal air sinus may be circular or slit-like, according to the manner in which the mucous membrane is disposed around it.

The term *meatus communis* is applied to the narrow cleft-like portion of the nasal cavity which extends from the roof to the floor between the septum medially and the conchæ laterally; and the part of the cavity which lies posterior to the conchal region, and between it and the choanæ, is the *naso-pharyngeal meatus* (Fig. 116, 17).

Muco-periosteum of the Lateral Walls of the Nasal Cavities.—It has been noted that the vestibule is lined with integument. The remainder of each lateral wall of the nasal cavity is covered with mucous membrane which is so closely blended with the subjacent periosteum that the two are inseparable and form a *muco-periosteum*. A similar membrane covers the roof and the floor. The muco-periosteum is continuous, through the naso-lacrimal duct, with the ocular conjunctiva; through the various apertures, with the delicate lining membrane of the air-cells which open into the nasal cavity, and, through the choanæ, with the pharyngeal mucous membrane. On the lateral wall, as on the septum, the muco-periosteum is separable into an upper, olfactory, and a lower, respiratory portion; but the subdivision cannot be appreciated by the naked eye, for the one district passes into the other without any sharp line of demarcation. The *olfactory region* comprises merely the region of the upper concha; the *respiratory region* includes the middle and inferior conchæ, the middle meatus, the inferior meatus, and the atrium. On the lower part of the lateral wall the muco-periosteum is thick and spongy, more particularly over the lower borders and posterior extremities of the middle and inferior conchæ, where the membrane presents an irregular surface and forms soft, bulging cushions. The spongy condition is due to the presence of a rich venous plexus, the vessels of which run, for the most part, in an antero-posterior direction. In the region of the inferior concha, the veins are so numerous that the muco-periosteum assumes the character of cavernous tissue, and is sometimes spoken of as the "erectile body." When turgid with blood it swells out and obliterates the interval between the concha and the septum. The muco-periosteum of the floor, meatuses and atrium, is smoother than, and not so thick as, that over the conchæ. Everywhere, numerous mucous glands are embedded in it, and the minute punctiform orifices of the ducts are visible to the naked eye. In the olfactory region the lining membrane of the nose, in the fresh state, is of a yellowish colour, and it is softer and more delicate than in the respiratory part.

The great vascularity of the mucous membrane of the nose is, doubtless, for the purpose of moistening and raising the temperature of the inspired air.

Nerves and Vessels on the Lateral Wall of the Nasal Cavity:—

Nerves of Smell, .	Olfactory nerves.
Nerves of Common Sensation, . .	1. Lateral nasal branches of anterior ethmoidal. 2. Nasal branch of anterior superior alveolar. 3. Posterior superior nasal branches from spheno-palatine ganglion and from the nerve of the pterygoid canal. 4. Two posterior inferior nasal branches from the anterior palatine nerve.

The *olfactory nerves* are from twelve to twenty in number. They are formed by numerous fine nerve filaments, which spring from the olfactory cells of the olfactory mucous membrane, and they are arranged in two groups; a *medial* or *septal group*, from the upper part of the septum (p. 307), and a *lateral group*, from the upper third of the lateral wall of the nasal cavity. The nerve filaments lie in the muco-periosteum, but the nerves which they form are lodged in shallow bony grooves and small bony canals in the walls of the nasal cavity. At the roof of the nose the nerves pass through the foramina in the cribriform plate of the ethmoid; then they pierce the meninges, from which they derive sheaths, and they end in the lower part of the olfactory bulb of the same side.

Dissection.—Follow the naso-palatine nerve, which was exposed on the nasal septum, across the roof of the nasal cavity to the spheno-palatine foramen in the lateral wall of the nose. By dissecting carefully in the muco-periosteum in the neighbourhood of the foramen, in a good part, the dissector may be able to display one or more of the posterior superior nasal nerves. At the same time he should display the spheno-palatine branch of the internal maxillary artery which enters the nose through the spheno-palatine foramen.

The *posterior superior nasal nerves* arise from the spheno-palatine ganglion and from the nerve of the pterygoid canal. In spite of the fact that they are minute filaments, the dissector should endeavour to trace them to their distribution upon the lateral wall. They enter the nose through the spheno-palatine foramen, which is situated at the posterior end of the superior meatus; and are distributed to the muco-periosteum over the upper and middle conchæ, and the posterior part of the septum.

Dissection.—Make a vertical incision through the muco-periosteum over the posterior part of the medial pterygoid lamina, then carefully raise the membrane, reflect it forwards and seek for the inferior nasal nerves. They both pierce the perpendicular plate of the palate bone; the upper one at a point on a level with the interval between the posterior ends of the middle and inferior conchæ, and the lower at the level of the posterior end of the inferior concha.

The *inferior nasal nerves* are two in number; they both arise from the anterior palatine nerve.

The *upper* of the two inferior nasal nerves emerges through a small aperture in the perpendicular part of the palate bone, at a point between the posterior extremities of the middle and inferior conchæ. It divides into an ascending and descending branch. Both run forwards; the former on the middle concha, the latter on the inferior concha. The *lower* of the two inferior nasal nerves appears through a foramen in the perpendicular part of the palate bone, immediately posterior to the inferior concha, upon which it is distributed.

The *anterior ethmoidal nerve* (O.T. *nasal*) should be exposed as it descends in the groove upon the deep surface of the nasal bone (p. 252). It gives medial branches to the septum, and lateral branches to the muco-periosteum over the anterior part of the lateral wall, and to the anterior parts of the middle and inferior conchæ.

The main *artery* of supply to the nasal muco-periosteum is the *spheno-palatine*, a branch of the internal maxillary. It gains entrance to the nasal cavity through the spheno-palatine foramen, in company with the posterior superior nasal nerves. Its septal branch accompanies the naso-palatine nerve, whilst others are distributed upon the lateral wall of the cavity. Several twigs are given also by the *descending palatine branch* of the internal maxillary and the *two ethmoidal arteries*, but these are small and will be seen only in cases where the injection of the subject has been unusually successful.

SPHENO-PALATINE GANGLION AND INTERNAL MAXILLARY ARTERY.

The spheno-palatine ganglion is situated in the pterygo-palatine fossa, on the lateral side of the spheno-palatine foramen; and at this stage it can be exposed best by a dissection from the medial or nasal side.

Dissection.—The muco-periosteum has already been removed from the posterior part of the lateral wall of the nasal cavity, and the inferior nasal branches of the anterior palatine nerve have been found piercing the perpendicular part of the palate bone. The dissector cannot fail to notice the course taken by the trunk from which those filaments arise. The lamina of bone which forms the medial wall of the pterygo-palatine canal is so thin that the nerve can be distinctly seen through it. By carefully opening up the canal with a small chisel, and following the anterior palatine nerve upwards, the dissector will be led to the ganglion in the pterygo-palatine fossa. The naso-palatine nerve should at the same time be traced to its origin. The ganglion is so hemmed in by the bony walls of the fossa that it is very difficult to display it thoroughly;

but by removing the orbital process of the palate bone, and a portion of the body of the sphenoid, with the bone forceps, the dissector may expose it more or less satisfactorily. In the same restricted space will be found the terminal portion of the internal maxillary artery, from which numerous branches are given off.

Ganglion Sphenopalatinum.—The spheno-palatine ganglion is a small, triangular flattened body, which is lodged in the pterygo-palatine fossa. It is embedded in fat, and is surrounded by the terminal branches of the internal maxillary artery. Two stout spheno-palatine branches descend to it from the maxillary nerve, but only some of their fibres end in the ganglion; the remainder are continued directly into the nasal and palatine nerves which proceed from the ganglion. The spheno-palatine branches may be regarded as constituting the *sensory roots* of the ganglion.

From the spheno-palatine ganglion branches are given off which radiate in four directions—viz., medially, to the nose; downwards, to the palate; backwards, to establish connections with the facial nerve and carotid plexus, as well as to supply the mucous membrane of the pharynx; and, forwards, to the orbit.

Medial branches, .	Posterior superior nasal nerves.
Descending branches,	Anterior palatine. Middle palatine. Posterior palatine.
Posterior branches, .	Nerve of pterygoid canal. Some lateral posterior superior nasal branches.
Anterior branches, .	Orbital.

From the internal maxillary artery twigs are given off which accompany the above-mentioned nerves.

Posterior Superior Nasal Nerves.—There are two groups of the posterior superior nasal nerves, a medial and a lateral. The medial branches pass through the spheno-palatine foramen and across the roof of the nasal cavity to the posterior part of the septum. The largest of them, the naso-palatine nerve, runs downwards and forwards in a groove on the surface of the vomer (p. 307). Some of the branches of the lateral posterior group also pass through the spheno-palatine foramen and are distributed to the superior meatus, to the superior and middle conchæ, and to the posterior ethmoidal air cells. Other branches of the lateral group pass backwards, some in the muco-periosteum of the upper and posterior part of the nasal cavity, and one in the pharyngeal canal (O.T. pterygo-palatine or pharyngeal nerve). They are distributed to the muco-periosteum of the posterior part of the roof of the nasal cavity, to the adjacent parts of the wall of the pharynx, to the sphenoidal air sinus, and to the pharyngeal part of the auditory tube.

The *descending branches* are the palatine nerves, and with them are incorporated the posterior inferior nasal nerves. The palatine nerves are three in number, anterior (O.T. great or posterior palatine), middle, and posterior. As a rule the three spring, by a common trunk, from the lower aspect of the ganglion. The trunk descends in the pterygo-palatine canal, which has been opened up already, but to expose the nerves a dense fibrous investment must also be removed. The nerve-trunk will then be seen breaking up into its constituent parts.

Dissection.—Trace, in the first instance, the two smaller nerves—viz., the middle and posterior palatine branches. They leave the main canal and enter the lesser palatine canals, which conduct them through the pyramidal process of the palate bone. It is well to secure the nerves as they emerge from the lower openings of the canals, before opening the canals. The dissector can readily find them by dissecting posterior to the hamulus of the medial pterygoid lamina and gently separating the soft parts from the under aspect of the pyramid of the palate bone. As the dissection is being made from the medial side, the *middle palatine nerve* will be first encountered, and it will be seen to pass backwards into the soft palate, under cover of the tendinous expansion of the tensor veli palatini.[1] The tensor must be divided, in order that the nerve may be followed to its distribution. The *posterior palatine nerve* will be found issuing from its canal a short distance to the lateral side of the preceding nerve. It is distributed to the soft palate in the neighbourhood of the palatine tonsil. It is smaller than the middle palatine nerve, and is sometimes absent. The large *anterior palatine nerve* should now be followed onwards to the hard palate. To do that, open up the lower part of the pterygo-palatine canal by removing a small portion of the posterior and lateral part of the horizontal plate of the palate bone.

The *anterior palatine nerve* is the largest branch of the spheno-palatine ganglion. It descends through the pterygo-palatine canal, accompanied by the great palatine branch of the internal maxillary artery; it enters the palate through the greater palatine foramen and runs forwards, in a groove on the

[1] The present is a good opportunity to observe the corrugated or wrinkled appearance of the tendon of the tensor, as it passes under the hamulus.

lower aspect of the hard palate, towards the incisive foramen. It supplies the gum, the mucous membrane, and the glands of the vault of the mouth; and, in the neighbourhood of the incisive foramen, it communicates with the naso-palatine nerve. As it passes down the pterygo-palatine canal the posterior inferior nasal branches, which were enclosed in its sheath, leave it and enter the nasal cavity (p. 316).

Whilst tracing the anterior palatine nerve in the palate, the dissector should note the numerous glands which are placed under the mucous membrane of the vault of the mouth, and the manner in which they indent the bone.[1]

Dissection.—The dissector will experience some difficulty in exposing the nerves in the pharyngeal and pterygoid canals, which are very inaccessible.

To open up the pharyngeal canal the sphenoidal process of the palate bone must be cautiously removed with the bone forceps, and then the dissector should proceed to open up the pterygoid canal (O.T. Vidian), which traverses the root of the pterygoid process. As the bone is very hard and brittle in this region, the dissection must be effected very carefully.

The *nerve of the pharyngeal canal* belongs to the posterior superior nasal group (p. 318).

Nervus Canalis Pterygoidei (O.T. *Vidian*).—The nerve of the pterygoid canal is formed by a junction between the *greater superficial petrosal branch* of the facial and the *great deep petrosal branch* of the carotid plexus. It traverses the pterygoid canal, and joins the posterior aspect of the spheno-palatine ganglion, of which it may be considered to represent both the *motor* and *sympathetic root.* In the canal it is invested by a strong fibrous envelope, and when that is removed the nerve may sometimes be noticed to break up into a fine plexus which surrounds the accompanying artery. It has already been seen to give some fine filaments to the muco-periosteum of the nose.

Rami Orbitales.—The orbital branches of the ganglion are exceedingly minute; they pass forwards, through the inferior orbital fissure, to supply the periosteum of the orbit.

Termination of Internal Maxillary Artery.—The internal

[1] An equally good method of tracing the anterior palatine nerve is to remove the palatal processes of the palate and maxilla with the bone forceps, and then to display the nerve and artery on the upper surface of the mucous membrane and glands.

maxillary artery breaks up into its terminal branches in the pterygo-palatine fossa. They are—

1. Posterior superior alveolar (p. 174).
2. The infra-orbital (p. 303).
3. The descending palatine.
4. The spheno-palatine.

Arteria Palatina Descendens.—The descending palatine artery is a terminal branch of the internal maxillary artery. As it descends, in the pterygo-palatine fossa, it gives off, usually, the artery of the pterygoid canal, and, as it enters the pterygo-palatine canal, several small palatine arteries spring from it; then it becomes the *great palatine artery.* The great palatine artery descends through the great palatine foramen into the hard palate; there it runs forwards to reach the incisive foramen, through which it passes into the nasal cavity to anastomose with the posterior artery of the septum, which is an offset of the spheno-palatine artery.

The *small palatine arteries* spring from the descending palatine, immediately before it becomes the great palatine artery, in the upper part of the pterygo-palatine canal; they descend through the small palatine canals, and are distributed to the soft palate, the palatine arches, and to the palatine tonsil.

Arteria Spheno-palatina.—The spheno-palatine artery enters the nasal cavity through the spheno-palatine foramen. It gives off (1) a branch to the sphenoidal air sinus, (2) a branch which passes backwards through the pharyngeal canal (O.T. pterygo-palatine artery) to be distributed to the roof of the posterior part of the nasal cavity and to the roof of the pharynx; that branch anastomoses with the ascending pharyngeal artery. Then the spheno-palatine artery divides into lateral and septal posterior nasal branches. The lateral branches are distributed to the lateral wall of the nasal cavity, where they anastomose with the branches of the posterior and anterior ethmoidal arteries, and with the lateral nasal branch of the external maxillary. They supply not only the muco-periosteum of the lateral wall of the nasal cavity, but also the muco-periosteum of the air sinuses which open into the cavity. The posterior septal branch of the spheno-palatine artery accompanies the posterior nasal septal nerve along the surface of the vomer; it anastomoses with the great palatine artery, and with the septal branch of the superior labial artery.

THE LARYNX.

The portions of the mandible which are still attached, by mucous membrane, to the sides of the tongue, should be removed, and the dissection of the larynx should be commenced.

General Construction and Position.—The larynx is the upper expanded portion of the wind-pipe which is specially modified for the production of the voice. Its walls are composed of cartilages, muscles, ligaments and membranes, and it has an internal lining of mucous membrane. Before proceeding with the dissection the student should study the form and connections of the nine laryngeal cartilages in a permanent specimen (*v.* p. 338).

The larynx is placed in the upper and anterior part of the neck, where it forms a marked projection. It lies below the hyoid bone and tongue, and is directly continuous with the trachea inferiorly. *Anteriorly* it is covered by the skin and fasciæ, and, on each side of the median plane, by two thin strata of muscles—viz., the sterno-hyoid and omo-hyoid; the sterno-thyreoid and the thyreo-hyoid. Frequently a narrow process of the thyreoid gland, termed the *pyramidal lobe*, is continued upwards on its anterior surface. On *each side* a lobe of the thyreoid gland is prolonged upwards upon it, deep to the muscles; and it is related to the great vessels of the neck. *Posteriorly* it is in relation to the pharynx, which separates it from the prevertebral muscles. If the tip of the epiglottis is taken as its upper limit, the larynx, in the adult, may be regarded as being placed anterior to that portion of the vertebral column which extends from the lower border of the second to the lower border of the sixth cervical vertebra; but the position is not fixed: it varies with the movements of the head, and also during deglutition and phonation.

Interior of the Larynx.—The cavity of the larynx is smaller than might be expected from an inspection of its exterior. When its interior is examined from above, it will be seen to be subdivided into three portions by two elevated folds of mucous membrane which extend antero-posteriorly, and project inwards from each side of the cavity. The upper pair of folds are termed the *plicæ ventriculares* (O.T. *false vocal cords*); the lower pair receive the name of the *plicæ vocales*

(O.T. *true vocal cords*). The vocal folds are the chief agents in the production of the voice, and the larynx is so constructed that changes in their relative position, and in their degree of tension, are brought about by the action of the muscles and the recoil of the elastic ligaments.

Vestibulum Laryngis.—The vestibule is the upper subdivision of the laryngeal cavity (Figs. 111, 119); it extends from the superior aperture (*aditus laryngis*) of the larynx down to the ventricular folds. Its lower part is compressed from side to side. Its width, therefore, diminishes from above downwards, whilst, owing to the obliquity of the aditus, the anterior wall is longer than the posterior. The *anterior wall* is formed by the posterior surface of the epiglottis and the thyreo-epiglottic ligament, both covered with mucous membrane. It descends obliquely from above downwards and slightly forward and becomes narrower as it approaches the anterior ends of the ventricular folds. Each *side wall* of the vestibule is formed by the medial surface of a fold of mucous membrane called the ary-epiglottic fold. For the most part it is smooth and slightly concave, but in its posterior part the mucous membrane bulges medially, in the form of two vertical elevations, placed one posterior to the other. The anterior elevation is formed by the enclosed cuneiform cartilage and a mass of glands associated with it;

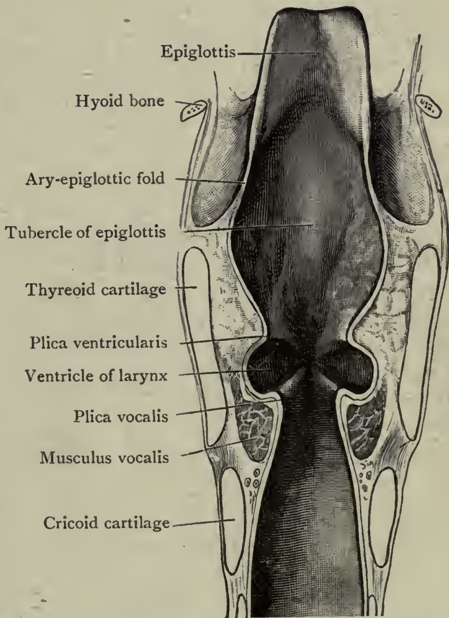


FIG. 118.—Frontal section through the Larynx, to show the Compartments.

the posterior elevation is due to the anterior margin of the arytænoid cartilage and the corniculate cartilage. A shallow groove descends between the two elevations; it terminates below by running into the interval between the ventricular and the vocal folds. The *posterior wall* of the vestibule is narrow. It is formed by the mucous membrane which covers the anterior surface of the arytænoideus muscle and it occupies the interval between the two arytænoid cartilages.

The *aditus laryngis* has already been examined, in the dissection of the pharynx (p. 291). The parts which bound it should again be carefully studied.

The *epiglottis* projects upwards, posterior to the median thyreo-hyoid ligament, the hyoid bone and the base of the tongue. Its lingual or anterior surface is free in the upper part of its extent only, and is attached to the pharyngeal part of the tongue by a prominent median fold of mucous membrane, termed the *glosso-epiglottic fold.* Two lateral folds are also present; they connect its margins with the walls of the pharynx at the side of the tongue, and are called the *pharyngo-epiglottic folds.* Between the two layers of mucous membrane which constitute each of the three folds, there is a small amount of elastic tissue. The depression on each side, between the tongue and the epiglottis, which is bounded by the glosso-epiglottic and a pharyngo-epiglottic fold is termed a *vallecula* (Fig. 119). The posterior free surface of the epiglottis forms the greater part of the anterior boundary of the vestibule of the larynx. The upper part of this surface is convex, owing to the manner in which the upper margin is curved towards the tongue; below the convexity there is a slight concavity, and still lower there is a marked bulging, over the upper part of the thyreo-epiglottic ligament. The last projection is called the *tubercle of the epiglottis*; it is a conspicuous object in laryngoscopic examinations of the larynx.

Each *ary-epiglottic fold* of mucous membrane encloses between its two layers some connective tissue, the ary-epiglottic muscle, and, posteriorly, the cuneiform cartilage, and the corniculate cartilage, which surmounts the arytænoid cartilage. As already mentioned, the two small nodules of cartilage produce elevations on the medial layer of the posterior part of the ary-epiglottic fold, which are easily seen when the larynx is examined with the laryngoscope.

The **Middle Subdivision of the Laryngeal Cavity** (Fig. 118) is the smallest of the three sections. It is bounded by the ventricular folds, above, and by the vocal folds below; it communicates with the vestibule above, and with the inferior compartment of the larynx below.

Plicæ Ventriculares (O.T. *False Vocal Cords*).—The ventricular folds are two prominent mucous folds which extend, antero-posteriorly, across the side walls of the laryngeal cavity. They are soft and somewhat flaccid, and their free borders are slightly arched, with the concavities looking downwards. Each fold contains—(1) a ventricular ligament; (2) numerous glands, which are aggregated chiefly in its middle part; and (3) a few muscle fibres. The interval between the ventricular folds is termed the *rima vestibuli*; it is consider-

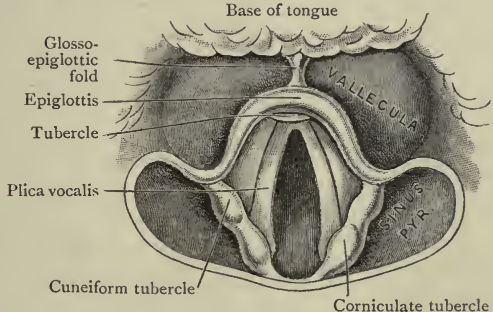


FIG. 119.—The Larynx as seen in the living person by means of the Laryngoscope.

ably wider than that between the vocal folds. It follows, therefore, that the four folds are distinctively visible when the cavity of the larynx is examined from above, but the vocal folds alone can be seen when the cavity is examined from below.

Plicæ Vocales (O.T. *True Vocal Cords*).—The vocal folds are placed below the ventricular folds, and extend from the angle between the laminæ of the thyreoid cartilage, anteriorly, to the vocal processes of the arytænoid cartilages, posteriorly. Each vocal fold is sharp and prominent, and its mucous membrane is thin and is firmly bound down to the subjacent vocal ligament. In colour it is pale, almost pearly white, whilst, posteriorly, the point of the vocal process of the arytænoid cartilage, which stands out in relief, presents a yellowish tinge. In frontal section each vocal fold is somewhat prismatic in form, and the free border looks upwards and medially (Fig. 118).

The vocal folds are the agents by means of which the voice is produced. The ventricular folds are of little importance in that respect; indeed, they can be destroyed, in great part, without any appreciable effect upon the voice.

The *rima glottidis* is the elongated fissure by means of which the middle compartment of the larynx communicates with the lower subdivision. It is placed somewhat below the middle of the laryngeal cavity, of which it constitutes the narrowest part. Anteriorly, it is the interval between the vocal folds; posteriorly, it is the interval between the bases and vocal processes of the arytænoid cartilages (Fig. 121). It is composed, therefore, of two very distinct parts—(1) a narrow, anterior portion, between the vocal folds, involving less than two-thirds of its length, and called the *pars intermembranacea*; (2) a broader, shorter portion, between the arytænoid cartilages, termed the *pars intercartilaginea*. The form of the rima glottidis undergoes frequent alterations in the living person. During ordinary quiet respiration it is lanceolate in outline, and the intermembranous part has the form of an elongated triangle, with the base directed backwards. When the rima glottidis is widely opened the broadest part of the cleft lies between the extremities of the vocal processes of the arytænoid cartilages, and there each side of the rima presents a marked angle. The two vocal

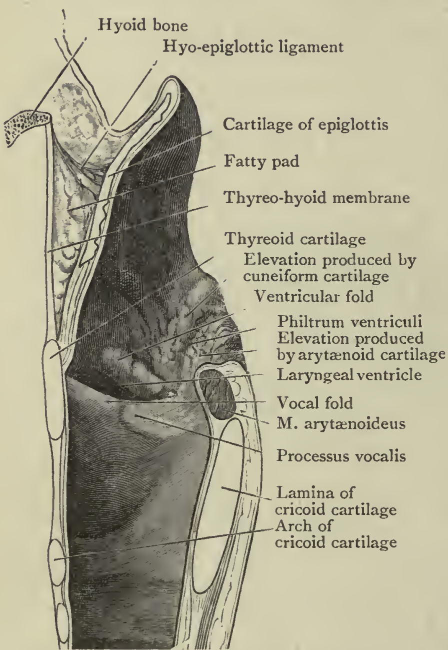


FIG. 120.—Median section through the Larynx, to show the Side Wall of its Right Half.

folds may, on the other hand, be approximated so closely to each other, as when a high note is sung, that the intermembranous part is reduced to a linear chink. The length of the entire fissure differs considerably in the two sexes. In the male its average length is 23 mm.; in the female, 17 mm.

In the side wall of the larynx, in the interval between the ventricular and the vocal folds, there is a pocket-like depression or recess, termed the *ventriculus laryngis* (O.T. *laryngeal sinus*).

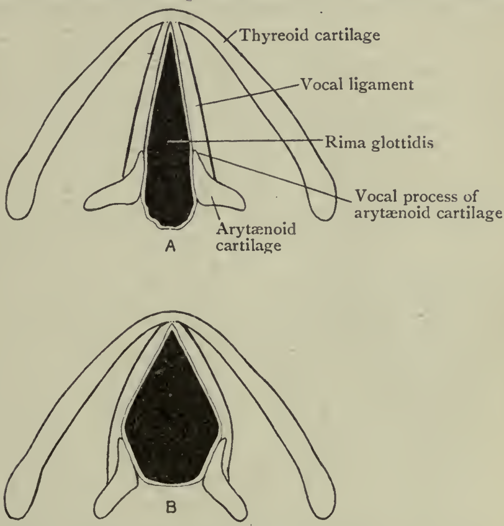


FIG. 121.—Diagram of the rima glottidis.

A. During ordinary easy breathing. B. Widely open.

The dissector should endeavour to gauge the extent of the ventricle, by means of a probe bent at the extremity. The recess passes upwards, undermining the ventricular fold, and its mouth or orifice is narrower than its cavity. Under cover of the anterior part of the ventricular fold a slit-like aperture will be detected. It leads into the *appendix ventriculi* (O.T. *laryngeal saccule*), a small diverticulum, which ascends between the ventricular fold and the lamina of the thyreoid cartilage. The appendix is of variable extent, but, as a rule, it ends blindly at the level of the upper border of the thyreoid cartilage.

Distend the ventricle, and, if possible, the appendix, with cotton wadding. This will greatly facilitate the subsequent dissection.

The **Lowest Subdivision of the Laryngeal Cavity** (Fig. 118) leads directly downwards into the trachea. Above, it is narrow and compressed from side to side, but it gradually widens out until in its lowest part it is circular. It is bounded by the mucous membrane which covers the sloping medial surface of the conus elasticus, and the inner aspect of the cricoid cartilage. It is through the anterior wall of the lowest compartment of the larynx that the opening is made in the operation of laryngotomy.

Mucous Membrane of the Larynx. — The mucous membrane of the larynx is continuous, above, with that lining the pharynx, and below, with the mucous lining of the trachea. Over the laryngeal or posterior surface of the epiglottis it is closely adherent, but elsewhere, above the level of the vocal folds, it is attached loosely by submucous tissue to the adjacent structures. As it passes over the vocal folds it is very thin and tightly bound down, and in inflammatory conditions of the larynx, attended with œdema, that attachment usually prevents the infiltration of the submucous tissue from extending downwards below the rima glottidis.

The mucous membrane of the larynx has a plentiful supply of racemose glands which secrete mucus, but over the surface of the vocal folds they are completely absent.

Dissection.—Place the larynx upon a block so that its anterior surface looks upwards, and fix it in that position with pins. The branches which the external laryngeal nerve gives to the crico-thyreoid muscle should in the first place be followed out; and, carefully preserving the superior and inferior laryngeal vessels and the internal and inferior laryngeal nerves, the dissector should in the next place proceed to remove the thyreoid gland, and the omo-hyoid, sterno-hyoid, sterno-thyreoid, and thyreo-hyoid muscles. The fibres of origin of the inferior constrictor muscle also should be taken away from the thyreoid and cricoid cartilages. The thyreo-hyoid membrane, the crico-thyreoid ligament, and the crico-thyreoid muscles are now exposed, and their attachments may be defined.

Membrana Hyo-thyreoidea.—The thyreo-hyoid membrane is a broad membranous sheet, which occupies the interval between the hyoid bone and the thyreoid cartilage. It is not equally strong throughout, but shows a central thick portion, the *median thyreo-hyoid ligament*, largely composed of elastic fibres, and cord-like right and left margins, the *lateral thyreo-hyoid* ligaments, whilst in the intervals between the central part and the lateral margins it is thin and weak. The median ligament is attached, above, to the posterior aspect of the upper margin of the body of the hyoid bone; below, it is fixed to the sides of the deep median notch on the upper border of the thyreoid cartilage. The upper part of its anterior surface, therefore, lies behind the hollowed-out posterior surface of the body of the hyoid bone; a mucous bursa is interposed between them, and in certain movements of the head and larynx the upper border of the thyreoid cartilage is allowed to slip upwards behind the hyoid bone. On each side of the strong central part, the thyreo-hyoid membrane is attached, below, to the upper margin of the lamina of the thyreoid cartilage, and, above, to the deep aspect of the greater cornu of the hyoid bone. It is pierced by the internal laryngeal nerve and superior laryngeal vessels. The lateral thyreo-hyoid ligament, which forms the posterior border of the membrane, on each side, is rounded and cord-like, and is composed chiefly of elastic fibres. It extends from the tip of the greater cornu of the hyoid bone to the extremity of superior cornu of the thyreoid cartilage. In it there is usually developed a small, oval cartilaginous or bony nodule, termed the *cartilago triticea* (Fig. 127).

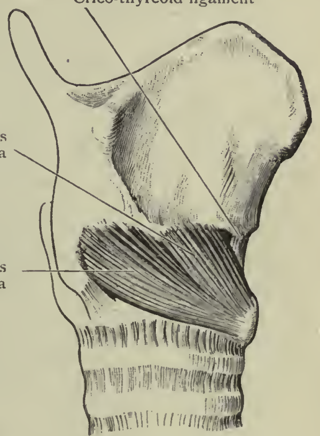


FIG. 122.—The Crico-thyreoid Muscle.

Musculus Crico-thyreoideus.—Each crico-thyreoid muscle is placed on the corresponding side of the cricoid cartilage, and bridges over the lateral portion of the crico-thyreoid interval. It takes origin from the lower border and outer surface of the arch of the cricoid cartilage, whence its fibres spread out in an upward and backward direction, and are inserted into the inner aspect of the lower margin of the thyreoid lamina, and also into the anterior border of its inferior cornu. As a general rule, it is divided into two parts. The *anterior* or *straight part* is composed of those fibres which are attached to the lamina of the thyreoid cartilage; the *posterior* or *oblique part* is formed of those fibres which are inserted into the inferior cornu of the thyreoid cartilage. It is closely associated with the origin of the inferior constrictor muscle. The crico-thyreoid muscle is supplied by the *external laryngeal branch* of the superior laryngeal nerve. The crico-thyreoid muscles are the chief tensors of the vocal ligaments.

Conus Elasticus.—Extending upwards, from the upper border of the anterior and lateral parts of the cricoid cartilage to the thyreoid and arytænoid cartilages, is a strong elastic membrane, the *conus elasticus*, which is separable into a median and two lateral parts. The median part is the *crico-thyreoid ligament*, which extends from the upper border of the anterior part of the cricoid arch to the lower border of the thyreoid cartilage. Each lateral part (O.T. lateral part of crico-thyreoid membrane) runs upwards and medially and terminates in a free, thickened border, called the *ligamentum vocale*, which lies in the substance of the plica vocalis, and is attached, posteriorly, to the vocal process of arytænoid, and, anteriorly, to the angle of union of the two laminæ of the thyreoid cartilage. The inner surface of the conus elasticus is covered with the mucous membrane of the lowest section of the cavity of the larynx, and the outer surfaces of the lateral parts are in relation with the lateral crico-arytænoid and the thyreo-arytænoideus muscles (Fig. 118).

Dissection.—The position of the larynx must now be reversed. Fix it upon the block in such a manner that its posterior aspect is directed upwards. The œsophagus should then be slit open by a median incision through its posterior wall. Next, remove the mucous membrane which covers the posterior aspect of the cricoid and arytænoid cartilages. Whilst doing that, bear in mind that the inferior laryngeal artery and the inferior laryngeal nerve pass upwards, between the thyreoid and cricoid cartilages, and must be preserved.

Upon the posterior aspect of the broad lamina of the cricoid cartilage the dissector will now note the two posterior crico-arytænoid muscles, and the attachment of the tendinous band through which the longitudinal fibres of the œsophagus are fixed to the cricoid cartilage. The band takes origin from the prominent median ridge on the posterior aspect of the cricoid cartilage. On the posterior surface of the arytænoid cartilages, and bridging across the interval between them, are the transverse and oblique parts of the arytænoid muscle. Especial care must be taken whilst that muscle is being cleaned, in order that the connections of the superficial decussating fibres may be ascertained fully.

The lateral layer of the left ary-epiglottic fold of mucous membrane should now be cautiously removed, to expose the ary-epiglottic muscle, the cuneiform cartilage, and the corniculate cartilage of that side. This is perhaps the most difficult part of the dissection, because the dissector has to establish the continuity of the sparse fibres, which compose the pale ary-epiglottic muscle, with the decussating fibres of the arytænoid muscle (Fig. 123).

FIG. 123.—Muscles of the Posterior Aspect of the Larynx.

Musculus Crico-arytænoideus Posterior.—Each posterior crico-arytænoid muscle is somewhat fan-shaped (Fig. 123). It springs, by a broad origin, from the depression which marks the posterior surface of the cricoid cartilage, on the corresponding side of the median ridge, and its fibres converge to be inserted into the posterior surface of the *muscular process* or projecting lateral angle of the base of the arytænoid cartilage.

As the fibres pass from origin to insertion, they run with different degrees of obliquity. The uppermost fibres are short and nearly horizontal; the intermediate fibres are the longest, and are very oblique; whilst the lowest fibres are almost vertical in their direction. The posterior crico-arytænoid muscles are abductors of the vocal folds. They are supplied by the inferior laryngeal nerves.

Musculus Arytænoideus.—The arytænoid muscle consists of two portions—a superficial part, termed the *arytænoideus obliquus*, and a deeper layer, called the *arytænoideus transversus.*

FIG. 124.—Side view of the Muscles of the Larynx. The fibres passing backwards and upwards from the upper border of the musculus vocalis are the fibres of the thyreo-epiglotticus. They blend above with the ary-epiglotticus.

The *arytænoideus obliquus* is composed of two bundles of muscular fibres, each of which springs from the posterior aspect of the muscular process of the corresponding arytænoid cartilage (Fig. 123). From those points the two fleshy slips proceed upwards and medially, and cross each other in the median plane like the limbs of the letter X. Some of the fibres are inserted into the summit of the arytænoid cartilage of the opposite side, but the greater proportion are prolonged, round the base of the corniculate cartilage, into the ary-epiglottic fold. There they receive the name of the *ary-epiglotticus muscle*, and, as they approach the epiglottis, they are joined by the fibres of the thyreo-epiglotticus muscle. The oblique arytænoid muscles may be considered as constituting a weak sphincter muscle for the superior aperture of the larynx. Each bundle starts from the base of one of the arytænoid cartilages and is prolonged into the ary-epiglottic fold of the opposite side, and onwards, along the fold, to the margin of the epiglottis.

The *arytænoideus transversus* is an unpaired muscle. It is composed of transverse fibres which bridge across the interval between the two arytænoid cartilages and are attached to the posterior aspect of the lateral border of each arytænoid cartilage. Many of the fibres turn round the arytænoid cartilage and become continuous, on each side, with the fibres of the thyreo-arytænoid muscle. Both groups of fibres are supplied by the inferior laryngeal nerves. The oblique fibres form a weak sphincter of the superior laryngeal aperture. The transverse fibres adduct the arytænoid cartilages and abduct the vocal folds.

Dissection.—The further dissection of the laryngeal muscles should be confined to the left side of the larynx. The right side should be reserved for the study of the nerves and vessels. Place the larynx on its right side, and, having fixed it in that position, remove the left crico-thyreoid muscle. The left lateral part of the thyreo-hyoid membrane should next be divided, and the left inferior cornu of the thyreoid cartilage disarticulated from its facet on the side of the cricoid cartilage. An incision should now be made through the left lamina of the thyreoid cartilage, a short distance to the left side of the median plane, and the detached piece must be carefully removed. Three muscles are now exposed, and must be cleaned. They are named, from below upwards :—

1. The lateral crico-arytænoid.
2. The thyreo-arytænoid.
3. The thyreo-epiglotticus.

Musculus Crico-arytænoideus Lateralis.—Each lateral crico-arytænoid muscle is triangular in form, and smaller than the posterior crico-arytænoid (Fig. 124). It springs from the upper border of the arch of the cricoid cartilage, extending to the facet on the lamina which supports the base of the arytænoid cartilage; a few of its fibres take origin from the conus elasticus also. From its lower attachment its fibres run backwards and upwards, and converge to be inserted into the anterior surface of the processus muscularis of the arytænoid cartilage. The superficial or lateral surface of the muscle is covered by the lamina of the thyreoid cartilage and the upper part of the crico-thyreoid muscle; its deep surface is applied to the conus elasticus. The lateral crico-arytænoid muscles are supplied by the inferior laryngeal nerves. They are adductors of the vocal folds.

Musculus Thyreo-arytænoideus (O.T. **Thyro-arytenoideus Externus**).—Each thyreo-arytænoid muscle springs from the angle of union of the two laminæ of the thyreoid cartilage, in close association with the vocalis. Its fibres pass backwards, and are inserted into the lateral surface of the arytænoid cartilage. It protracts the arytænoid cartilage, and adducts and relaxes the vocal fold. It is supplied by the inferior laryngeal nerve.

Dissection.—The lateral crico-arytænoid muscle should now be carefully removed, and at the same time the dissector should endeavour to disengage the fibres of the thyreo-arytænoideus from the deeper musculus vocalis, in order that the relation of the vocalis to the vocal ligament may be studied. Finally, remove the musculus vocalis. When the muscles are removed, the lateral surface of the conus elasticus, the vocal ligament, and the wall of the laryngeal ventricle will be displayed. By carefully dissecting between the two layers of mucous membrane which form the ventricular fold, the dissector may find the weak ventricular ligament, which supports the fold, as well as a number of racemose glands which lie in relation to it.

Musculus Thyreo-epiglotticus. — Each thyreo-epiglottic muscle springs from the thyreoid cartilage, immediately above the corresponding musculus vocalis, with the upper border of which it is more or less blended. Its fibres run backwards and upwards, into the ary-epiglottic fold, where they blend with the ary-epiglotticus, and they are inserted into the edge of the lower half of the epiglottis. The thyreo-epiglottic muscles depress the epiglottis. They are supplied by the inferior laryngeal nerves.

Musculus Vocalis.—Each musculus vocalis is a sheet of muscular fibres which springs, anteriorly, from the angle of union of the two laminæ of the thyreoid cartilage. It runs backwards, along the ligamentum vocale and the upper part of the conus elasticus, and is inserted into the lateral surface of the vocal process and the anterior surface of the body of the arytænoid cartilage. Its lower fibres blend with the upper margin of the lateral crico-arytænoid muscle, and the medial fibres, which run along and to a certain extent are attached to the ligamentum vocale,[1] form a bundle, triangular in frontal section, to which the term internal thyro-arytænoid muscle was formerly applied. The vocalis muscles protract the arytænoid cartilages, and adduct and relax the vocal folds. They are supplied by the inferior laryngeal nerves.

Ligamentum Vocale.—There are two vocal ligaments, right and left. Each is the thickened free upper border of

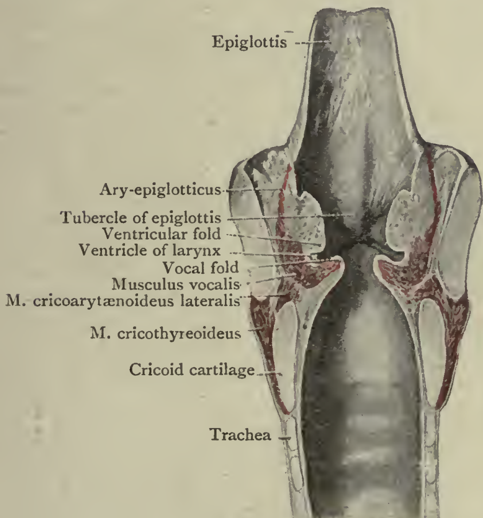


FIG. 125.—Frontal section of Larynx, showing Muscles.

the corresponding lateral part of the conus elasticus, and it constitutes the support of the vocal fold. *Anteriorly*, it is attached, close to its fellow of the opposite side, to the middle of the angular depression between the two laminæ of the thyreoid cartilage. *Posteriorly*, it is attached to the tip and upper border of the processus vocalis, which projects forwards from the base of the arytænoid cartilage. The vocal ligament is composed of yellow elastic fibres. Its medial border is sharp and free, and is clothed with mucous membrane,

[1] The fibres which are attached to the ligamentum vocale are called collectively the *ary-vocalis muscle.*

which is thin and firmly bound down to the ligament. Embedded in its anterior extremity there is a minute nodule of condensed elastic tissue, called the *sesamoid cartilage.*

Dissection.—By removing the mucous membrane in the region of the rima glottidis and the laryngeal ventricle a good view of the parts which bound the rima will be obtained—viz., *anteriorly*, the angle of the thyreoid cartilage; *posteriorly*, the arytænoideus transversus muscle; *on each side*, the vocal ligament, the processus vocalis, and the medial surface of the arytænoid cartilage (p. 343). They are all clothed with the lining mucous membrane of the larynx.

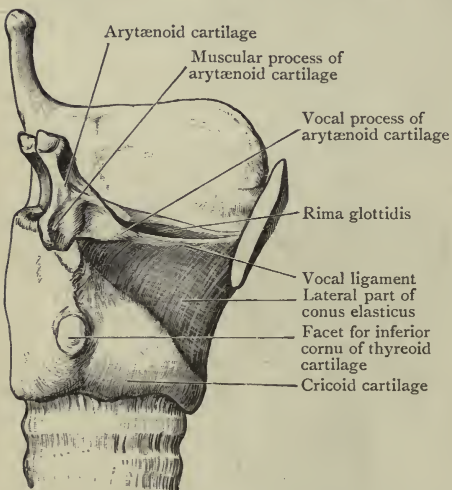


FIG. 126.—Conus elasticus. The right lamina of the thyreoid cartilage, etc., have been removed.

Ligamentum Ventriculare.—The feeble ventricular ligaments support the ventricular folds. Each is weak and indefinite, but somewhat longer than the corresponding vocal ligament. Anteriorly, each ventricular ligament is attached to the angular depression between the two laminæ of the thyreoid cartilage, above the vocal fold and immediately below the attachment of the thyreo-epiglottic ligament; and it extends backwards to a tubercle on the lateral surface of the arytænoid cartilage above the processus vocalis. It is composed of connective tissue and elastic fibres, which are continuous with the fibrous tissue in the ary-epiglottic fold.

Dissection.—Remove the remains of the ary-epiglottic fold, the ventricular and the vocal folds, and the lateral part of the conus elasticus, on the left side of the larynx, but be careful not to injure the arytænoid cartilage or the corniculate cartilage. If the cuneiform cartilage is present in the ary-epiglottic fold it should be detached and preserved. By this dissection a good view of the side wall of the laryngeal cavity can be obtained.

The undissected vocal fold of the right side should be examined again ; the laryngeal ventricle and appendix should be explored, and their precise connections and extent determined. When the dissector has satisfied himself about those points he can proceed to display the vessels and nerves of the larynx. The superior laryngeal artery and the internal laryngeal nerve reach the pharynx by piercing the lateral thin part of the thyreo-hyoid membrane, and they descend, along the lateral wall of the recessus piriformis, to the larynx. By applying traction to the nerve, and at the same time dividing the mucous membrane upon the medial surface of the thyreo-hyoid membrane, the dissector can easily find the nerve and artery. As the branches into which they divide are followed, the mucous membrane must be gradually removed from the wall of the larynx. The inferior laryngeal artery and nerve enter from below and proceed upwards, under cover of the lamina of the thyreoid cartilage. They can be satisfactorily displayed only by the removal of that piece of cartilage, but the dissector is not recommended to adopt the method suggested unless another larynx is available for the examination of the cartilages and joints. If the thyreoid cartilage is drawn laterally the more important branches can be studied.

Ramus Internus Nervi Laryngei Superioris.—In the dissection of the neck the internal laryngeal nerve of each side was seen springing from the superior laryngeal branch of the corresponding vagus. It is a sensory nerve, and its branches are distributed chiefly to the mucous membrane of the larynx. After piercing of the thyreo-hyoid membrane, it divides into three branches. The *uppermost* of the three sends filaments to the ary-epiglottic fold, to the mucous membrane which covers the epiglottis, to the folds anterior to it, and to the lower and middle part of the back of the tongue. The twigs which go to the epiglottis ramify on its posterior surface, but many of them pierce the cartilage to reach the mucous membrane on its anterior surface. The *middle branch* of the internal laryngeal nerve breaks up into filaments which are given to the mucous membrane lining the side wall of the larynx. The *lowest branch* descends and gives filaments to the mucous membrane on the lateral and posterior aspects of the arytænoid and cricoid cartilages. It also gives off a fairly large twig which runs downwards upon the posterior aspect of the cricoid cartilage to join the laryngeal branch of the recurrent nerve.

Nervus Recurrens.—Each recurrent nerve has previously been seen arising from the corresponding vagus, and it has been traced, in the neck, up to the point where it disappears under cover of the lower border of the inferior constrictor muscle and becomes the *inferior laryngeal nerve*, which ascends upon the lateral aspect of the cricoid cartilage, immediately posterior to the crico-thyreoid joint. There it is joined by the communicating twig from the internal laryngeal nerve, and almost immediately afterwards it divides into two branches. The *larger* of the two proceeds upwards, under cover of the lamina of the thyreoid cartilage, and breaks up into filaments which supply the lateral crico-arytænoid, the thyreo-arytænoid, the vocalis and the thyreo-epiglottic muscles; the *smaller* or *posterior branch* inclines upwards and backwards, upon the posterior aspect of the cricoid cartilage, and under cover of the posterior crico-arytænoid muscle. It supplies twigs to that muscle, and is then continued onwards to end in the arytænoid muscles.

The inferior laryngeal nerve is, therefore, the motor nerve of the larynx. It supplies all the muscles, with the exception of the crico-thyreoid, which obtains its nerve-supply from the external laryngeal. The inferior laryngeal nerve, however, contains a few sensory fibres also. Those it gives to the mucous membrane of the larynx below the rima glottidis.

Laryngeal Arteries.—The *superior laryngeal artery*, a branch of the superior thyreoid, accompanies the internal laryngeal nerve; the *inferior laryngeal artery*, which springs from the inferior thyreoid, accompanies the inferior laryngeal nerve. The two vessels ramify in the laryngeal wall and supply the mucous membrane, glands, and muscles.

Laryngeal Cartilages and Joints.—The cartilages which constitute the skeleton of the larynx and give support to its wall are the following:—

1. Thyreoid, 2. Cricoid, 3. Cartilage of the epiglottis,	single.	4. Arytænoid, 5. Corniculate, 6. Cuneiform,	paired.

They are connected by certain ligaments.

Dissection.—The mucous membrane and muscles must be carefully removed from the cartilages, and the ligaments must be defined. Exercise great caution while cleaning the arytænoid cartilages and the corniculate cartilages, in order that the latter may not be injured.

Cartilago Epiglottica.—The epiglottic cartilage is a thin, leaf-like lamina of yellow fibro-cartilage which is placed posterior to the tongue and the body of the hyoid bone, and anterior to the upper aperture of the larynx. When divested of the mucous membrane which covers it posteriorly and also, to some extent, anteriorly, the epiglottic cartilage has the form of an obovate leaf; it is indented by pits, and shows numerous perforations. In the pits glands are lodged, and through the foramina vessels and, in some cases, nerves pass. The broad end of the cartilage is directed upwards, and is free; its lateral margins are to a large extent enclosed within the ary-epiglottic folds. The anterior surface is free only in its upper part. That part is covered with mucous membrane, and looks towards the tongue. The posterior surface is covered, throughout its whole extent, with the mucous membrane of the larynx. The pointed lower end of the cartilage is called *the petiolus*, and is connected by a stout fibrous band, termed the thyreo-epiglottic ligament, to the angle between the laminæ of the thyreoid cartilage.

Epiglottic Ligaments. — The epiglottis is bound by ligaments to the base of the tongue, to the side wall of the pharynx, to the hyoid bone, and to the thyreoid cartilage. The *glosso-epiglottic fold* and the two *pharyngo-epiglottic folds* have been studied already. In each there is a small quantity of elastic tissue. The *hyo-epiglottic ligament* is a short, broad elastic band which connects the anterior face of the epiglottis to the upper border of the body of the hyoid bone. The *thyreo-epiglottic ligament* is strong, elastic, and thick. It proceeds downwards, from the lower pointed extremity of the epiglottis, and is attached to the angular depression between the two laminæ of the thyreoid cartilage, below the median notch.

The triangular interval which is left between the lower part of the cartilage of the epiglottis and the median part of the thyreo-hyoid membrane contains a pad of soft fat, and it is imperfectly closed above by the hyo-epiglottic ligament.

Cartilago Thyreoidea.—The thyreoid cartilage is the largest of the laryngeal cartilages. It is composed of two broad and somewhat quadrilateral plates, termed the *laminæ*, which meet anteriorly at an angle, and become fused along the median plane. Posteriorly, the laminæ diverge from each other and enclose a wide angular space. The *anterior borders* of the laminæ are fused only in their lower parts. Above, they are separated by a deep, narrow V-shaped notch, called the *incisura thyreoidea superior*. In the adult male, the angle formed by the meeting of the anterior borders of the two laminæ, especially in the upper part, is very projecting; and, with the margins of the superior thyreoid notch, which lies above, it constitutes a marked subcutaneous prominence in the neck, which receives the name of the *laryngeal prominence* (O.T. *pomum Adami*). The *posterior border* of each lamina is thick and rounded, and is prolonged, beyond the superior and inferior borders of the lamina, in the form of two slender cylindrical processes, termed the cornua. The *superior cornu*,

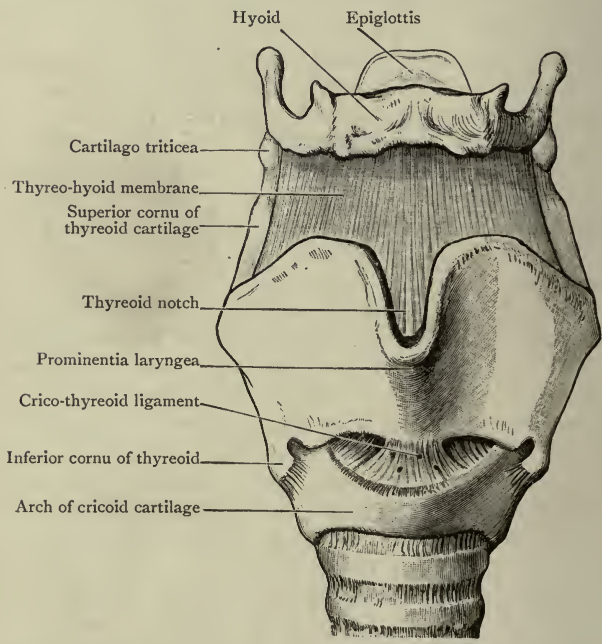


FIG. 127.—Anterior aspect of the Cartilages and Ligaments of Larynx.

longer than the inferior cornu, gives attachment to the lateral thyreo-hyoid ligament. The shorter, stronger *inferior cornu* curves slightly medially. On the medial aspect of its tip there is a facet which articulates with the side of the cricoid cartilage. The *superior border* of the lamina is for the most part slightly convex, and anteriorly it dips down to become continuous with the margin of the superior thyreoid notch. The *inferior border* is to all intents and purposes horizontal, but it is divided by a projection, termed the *inferior tubercle*, into a short posterior part and a longer anterior part. The *lateral surface* of the lamina is relatively flat. Immediately below the posterior part of the upper border, and anterior to the root of the superior cornu, there is a distinct prominence called the *superior tubercle.* From that point an oblique ridge descends towards the inferior tubercle on the lower border of the lamina. The ridge gives attachment to the sterno-thyreoid, thyreo-hyoid and the inferior constrictor muscles, and divides the lateral surface of the lamina into an anterior and a posterior part. To the posterior part, which is much the smaller of the two, is attached the inferior constrictor muscle of the pharynx. The *medial surface* of the lamina is smooth and slightly concave. To the angular depression between the two laminæ are attached the thyreo-epiglottic ligament, the ventricular and the vocal ligaments.

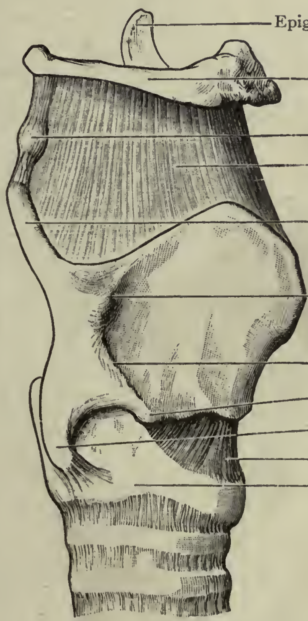


FIG. 128.—Profile view of Cartilages and Ligaments of Larynx.

Crico-thyreoid Joints.—The articulation, on each side, between the tip of the inferior cornu of the thyreoid cartilage and the side of the cricoid cartilage, belongs to the diarthrodial variety. The opposed surfaces are surrounded by an articular capsule which is lined with a synovial stratum. The movements which take place at the joints are of a twofold character—viz., (1) gliding; (2) rotatory. In the first case the cricoid facets glide upon the thyreoid surfaces in various directions. The rotatory movement is one in which the cricoid cartilage rotates around a transverse axis which passes through the centres of the two joints. Each articular capsule is strengthened by stout bands on the posterior aspect of the joint (Fig. 129).

Dissection.—**Divide the ligaments which surround the crico-thyreoid joint, and remove the thyreoid cartilage.**

Cartilago Cricoidea.—The cricoid cartilage is shaped like

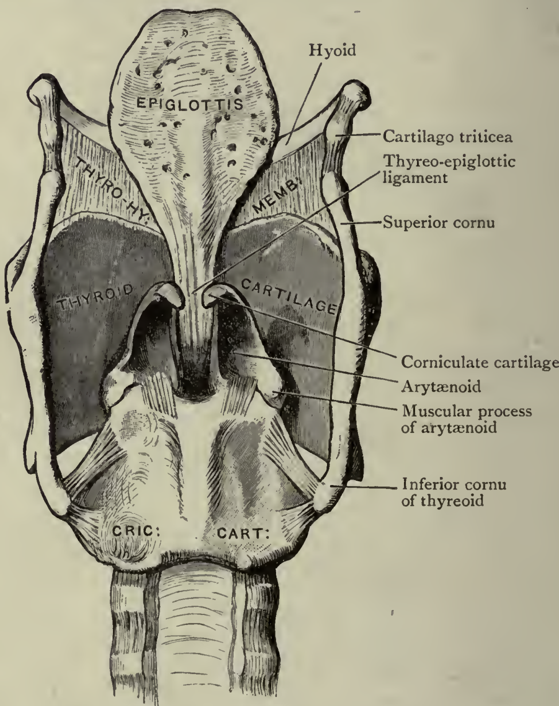


FIG. 129.—Posterior aspect of Cartilages and Ligaments of Larynx.

a signet ring. The broad, posterior part, called *the lamina*, is somewhat quadrangular in form. Its superior border presents a faintly marked median notch, and on each side of the notch there is an oval, convex facet which articulates with the base of the arytænoid cartilage. The posterior surface of the lamina is divided, by an elevated median ridge, into two slightly hollowed-out areas which give attachment to the posterior crico-arytænoid muscles. The median ridge itself gives origin to a tendinous band which proceeds upwards from the longitudinal fibres of the œsophagus. The anterior part of the cricoid cartilage is the *arch*, and it narrows anteriorly. The lower border of the arch is horizontal, and is connected to the first tracheal ring by membrane, the *crico-tracheal ligament*. The upper border is connected, anteriorly, to the lower border of the thyreoid cartilage by the crico-thyreoid ligament. Posteriorly, the upper border rapidly ascends, and to it is attached the corresponding half of the conus elasticus. Upon the posterior part of the lateral surface of the cricoid cartilage there is a circular, slightly elevated, convex facet, which looks laterally and upwards, for articulation with the inferior cornu of the thyreoid cartilage. Internally, the cricoid cartilage is lined with mucous membrane.

The narrow band-like part of the anterior arch of the cricoid cartilage lies below the lower border of the thyreoid cartilage, whilst the lamina is received into the interval between the posterior portions of the laminæ of the thyreoid cartilage.

Cartilagines Corniculatæ.—Before proceeding to the study of the arytænoid cartilages the dissector should examine the corniculate cartilages and the manner in which they are held in position. They are two minute pyramidal nodules of yellow elastic cartilage which are placed on the summits of the arytænoid cartilages, and are directed backwards and medially. Each corniculate cartilage is enclosed within the corresponding ary-epiglottic fold of mucous membrane, and is joined to the apex of the arytænoid cartilage by a synchondrodial joint.

Cartilagines Arytænoideæ.—Commence the study of the arytænoid cartilages by noting their relation to one another and to the cricoid cartilage. Then remove one cartilage and examine its surfaces and borders. Retain the other cartilage in position for the purpose of examining the crico-arytænoid joint and the movements which can be performed at that articulation.

The *arytænoid cartilages* are pyramidal in form, and they surmount the upper border of the lamina of the cricoid cartilage. The *apex* of each is directed upwards, and it curves backwards and medially. It supports the corniculate cartilage. Of the three surfaces, one looks medially, towards the corresponding surface of the opposite cartilage, from which it is separated by the rima glottidis; another looks backwards; whilst the third is directed antero-laterally. The *medial surface* is narrow, vertical and even, and is clothed with mucous membrane. The *posterior surface* is concave; it lodges and gives attachment to the arytænoideus transversus muscle. The *antero-lateral surface* is the most extensive of the three, and is uneven for muscular and ligamentous attachments. Upon that aspect of the arytænoid cartilage the musculus vocalis and the thyreo-arytænoid muscle are inserted. The surfaces of the arytænoid cartilage are separated by three borders, viz., an anterior, a posterior, and a lateral. The *lateral border* is the longest, and, at the base of the cartilage, it bulges backwards and laterally in the form of a stout, prominent angle or process, termed the *processus muscularis.* It gives attachment, anteriorly, to the crico-arytænoideus lateralis muscle; and, posteriorly, to the crico-arytænoideus posterior. The *anterior border* of the arytænoid cartilage is prolonged into the projecting anterior angle of the base, which is called the *processus vocalis.* The vocal process is sharp and pointed, and gives attachment to the vocal ligament (O.T. true vocal cord). The *base* of the arytænoid cartilage presents an elongated concave facet, on its under aspect, for articulation with the upper border of the lamina of the cricoid cartilage.

Crico-arytænoid Joints.—The crico-arytænoid joints are of the diarthrodial variety. Each has a distinct joint cavity, surrounded by an articular capsule, which is lined with a synovial stratum. The cricoid articular surface is convex; that of the arytænoid is concave; both are elongated in form, but they are placed in relation to each other so that the long axis of the one intersects or crosses that of the other, and in no position of the joint do the two surfaces accurately coincide. The movements allowed at the joints, as the dissector can readily determine, are of a twofold kind—(1) *gliding*, by which the arytænoid is carried medially or laterally, or, in other words, a movement by which the arytænoid advances towards or retreats from its fellow; (2) *rotatory*, by which the arytænoid cartilage rotates round a vertical axis. By that movement the vocal process is swung laterally or medially, so as to open or close the rima glottidis.

The dissector should note that the capsule of each joint is strengthened posteriorly by a strong band which restricts movement of the arytænoid cartilage.

Cartilagines Cuneiformes.—The cuneiform cartilages are two little rod-shaped nodules of yellow elastic cartilage, which are placed one in each ary-epiglottic fold near its posterior end (Fig. 120). They are not always present.

Actions of the Laryngeal Muscles.—The dissector should now consider the manner in which the muscles of the larynx operate upon the vocal folds, in the production of the voice. *Tension* of the vocal folds is produced by the contraction of the *crico-thyreoid muscles.* The straight parts of the muscles pull the upper border of the cricoid cartilage upwards, whilst the oblique portions, through their insertions into the inferior cornua, draw the cricoid cartilage backwards, thereby increasing the distance between the angle of the thyreoid cartilage and the vocal processes of the arytænoid cartilages. When the crico-thyreoid muscles cease to contract, the relaxation of the vocal folds is brought about by the elasticity of the ligaments. The vocalis and the thyreo-arytænoideus must be regarded as antagonistic to the crico-thyreoid muscles. When they contract they approximate the angle of the thyreoid cartilage to the arytænoid cartilages, and still further relax the vocal folds, and when they cease to act, the elastic ligaments of the larynx again bring about a state of equilibrium.

The *width of the rima glottidis* is regulated by the arytænoideus muscle, which draws together the arytænoid cartilages. The lateral and posterior crico-arytænoid muscles also modify the width of the rima glottidis. When they act together they assist the arytænoid muscle in closing the rima glottidis, but when they act independently they are antagonistic muscles. Thus the *crico-arytænoidei posteriores*, by drawing the muscular processes of the arytænoid cartilages backwards and laterally, swing the processus vocales and the vocal folds laterally, and thus open the rima. The *crico-arytænoidei laterales* act in exactly the opposite manner. By drawing the muscular processes in an opposite direction they close the rima.

But the muscles of the larynx have another function to perform besides that of vocalisation. It was formerly thought that the superior aperture of the larynx was closed, during deglutition, by the folding back of the epiglottis; that, in fact, the epiglottis, during the passage of the bolus of food, was applied like a lid over the entrance to the vestibule of the larynx. The investigations of Anderson Stuart have shown that the superior aperture of the larynx is closed during swallowing by the close apposition and the forward projection of the two arytænoid cartilages, which are forced against the tubercle of the epiglottis. The muscles chiefly concerned in that movement are the thyreo-arytænoid muscles and the transverse arytænoid muscle. They form, collectively, a true sphincter vestibuli. The ary-epiglottic muscles also assist in the closure.

THE TONGUE.

The tongue is a mobile organ which lies on the floor of the mouth. It consists of a mass of muscles covered with mucous membrane, and interspaced with a small amount of fat and some glands. It is closely associated with the functions of taste, mastication, deglutition, and articulation.

It has the form of a shoe turned upside down, and through the opening of the shoe, which corresponds with the *root* of the tongue, pass the muscles which connect the tongue with the hyoid bone and the mandible (Figs. 131, 133).

The free part of the tongue possesses a lower surface, and a dorsum. The dorsum is separable into an oral or upper portion, which is also called the upper surface and which terminates anteriorly at the *apex*, and a posterior or pharyngeal portion, which is also called the *base*. The *lower surface*, which is smooth, rests on the floor of the mouth. The *upper surface* is rough; it lies in relation to the roof of the mouth (Figs. 72, 110, and 114); the *apex* touches the incisor teeth, and the *base* forms a part of the anterior wall of the pharynx (Fig. 110). The upper border of the base is continuous with the upper surface and it forms the lower boundary of the isthmus of the fauces. The upper surface is separated from the lower surface, on each side, by a distinct but rounded border (Fig. 134).

The Mucous Membrane.—The tongue is covered with mucous membrane, which is continuous with the general lining of the oral cavity and pharynx, but which presents very different appearances on different areas of the tongue. In the middle line of the tongue, at the junction of the upper surface with the pharyngeal surface, there is a median pit in the mucous membrane called the *foramen cæcum.* From the foramen cæcum the two limbs of a V-shaped sulcus diverge antero-laterally, to terminate on the margins of the tongue at the attachments of the glosso-palatine arches. The V-shaped sulcus is called the *sulcus terminalis*; it is an indication of the double origin of the tongue; the part anterior to the sulcus, which lies in the floor of the mouth, and is, therefore, called the *oral part*, is developed from the mandibular arches and the associated *tuberculum impar* of the embryo; the

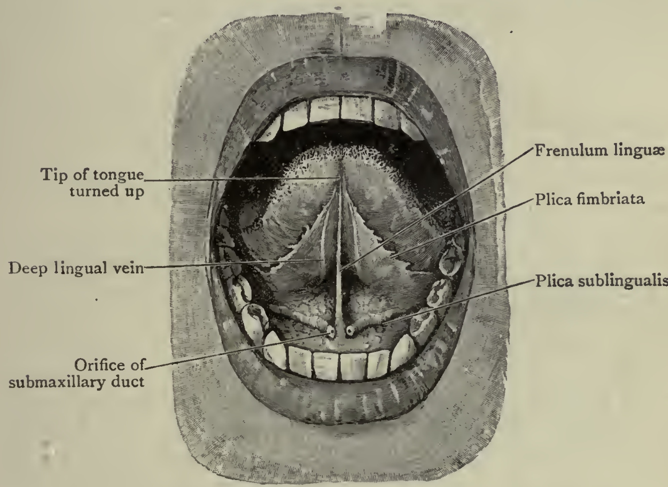


FIG. 130.—The Sublingual Region in the interior of the mouth.

posterior or *pharyngeal part* is developed from the second pair of visceral arches.

The mucous membrane of the pharyngeal surface lies in relation with the soft palate and the posterior wall of the pharynx, and it is continuous laterally with the mucous membrane of the palatine tonsils, and, posteriorly, with that of the epiglottis. Where it covers the pharyngeal surface of the tongue it is smooth and glossy and it has no projecting papillæ, but it is studded with low elevations, produced by masses of lymph follicles embedded in the submucous tissue, and in each elevation there is usually a small central pit. As the mucous membrane passes from the tongue to the epiglottis it is raised into a small median fold called the glosso-epiglottic fold.

Anterior to the foramen cæcum and sulcus terminalis the mucous membrane which covers the dorsum, sides, and tip of the oral part of the tongue is studded with papillæ of different kinds. As these are individually visible to the naked eye the mucous membrane presents a very characteristic appearance. Further, a median groove or sulcus extends backwards from the tip of the tongue to the foramen cæcum, and divides the anterior two-thirds of the dorsum into two halves.

On the inferior surface of the tongue the mucous membrane is smooth and comparatively thin. In the median plane it forms the *frenulum linguæ*, which has been studied at an earlier stage. On each side of the median line the deep lingual vein may be noticed, in the living subject, extending forwards towards the tip. To the lateral side of the vein, and, therefore, somewhat nearer the border of the tongue, is a delicate and feebly marked ridge of mucous membrane, from the free border of which a row of fringe-like processes or fimbriæ project. It is termed the *plica fimbriata*; as it extends forwards, towards the tip of the tongue, it inclines towards the median plane. On the side of the tongue, immediately anterior to the lingual attachment of the glosso-palatine arches, five short vertical fissures in the mucous membrane, separated by intervening folds, may be noticed. The folds are called the *papillæ foliatæ*. They are the representatives of leaf-like folds of the mucous membrane which are much more highly developed in certain of the lower animals (hare and rabbit), and which are specially concerned in receiving the impressions of taste.

Papillæ Linguales.—The papillæ are of four kinds, and differ in size, shape, and in the position they occupy on the surface of the tongue. They are termed the vallate, the fungiform, the conical, and the filiform.

Papillæ Vallatæ.—The vallate papillæ (O.T. circumvallate), seven to twelve in number, are the largest, and are placed immediately anterior to the sulcus terminalis, in two rows which diverge from each other in an antero-lateral direction, like the two limbs of the letter V. The foramen cæcum lies immediately posterior to the median vallate papilla, which forms the apex of the V. In form, a vallate papilla is broad and somewhat cylindrical, slightly narrower at its attached end than at its free extremity, and it is sunk in a pit. It is thus surrounded by a deep trench, the outer wall of which, termed the *vallum*, is slightly raised beyond the general surface of the mucous membrane, and forms an annular elevation which encircles the free extremity or summit of the papilla.

Papillæ Fungiformes.—The fungiform papillæ are much smaller, but are present in much greater numbers. They are found chiefly on the tip and sides of the tongue, but they are scattered, at irregular intervals, over the upper surface also. Each papilla presents a large, full, rounded, knob-like extremity, while it is greatly constricted at the point where it

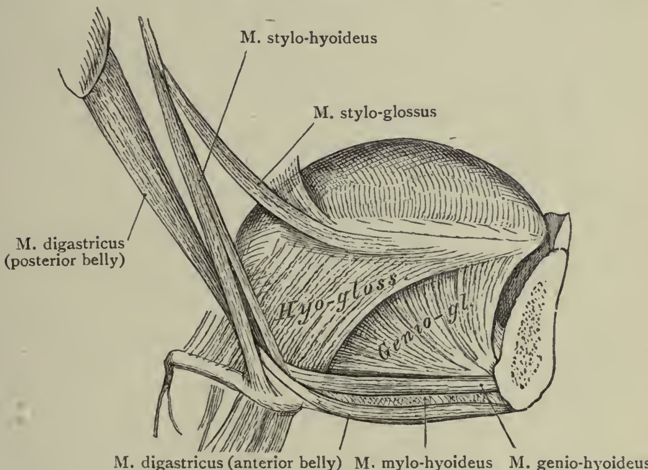


FIG. 131.—Muscles of the Tongue. (From Gegenbaur.)

springs from the mucous surface. In the living tongue the fungiform papillæ are distinguished by their bright red colour.

Papillæ Conicæ.—The conical papillæ are present in very large numbers. They are smaller than the fungiform variety, and although they are quite visible to the naked eye they can be more conveniently studied with an ordinary pocket lens. They are minute conical projections which taper towards their free extremities, and they occupy the dorsum and sides of the tongue, anterior to the sulcus terminalis. They are arranged in parallel rows which are placed close together. On the posterior part of the upper surface the rows diverge from the median sulcus in an antero-lateral direction. Towards the tip of the tongue the rows of conical papillæ become more or less transverse in direction, and on the sides of the tongue they are arranged perpendicularly.

Papillæ Filiformes.—The filiform papillæ are similar in general characters to the conical papillæ, but the epithelial cap at the apex of the cone is broken up into thread-like processes.

Muscles of the Tongue.—The tongue is composed almost entirely of muscular fibres, with some adipose and glandular and fibrous tissue intermixed. It is divided into two halves by a median septum, and the muscles in connection with each

FIG. 132.—Transverse section through the posterior part of the Tongue. (From Gegenbaur.)

half consist of an intrinsic and an extrinsic group. They are as follows:—

Extrinsic Muscles,
1. Genio-glossus.
2. Hyo-glossus.
3. Chondro-glossus.
4. Stylo-glossus.
5. Glosso-palatinus.

Intrinsic Muscles,
1. Superior longitudinal.
2. Inferior longitudinal.
3. Vertical.
4. Transverse.

The *extrinsic muscles* take origin from parts outside the tongue, and thus are capable not only of giving rise to changes in the form of the organ, but also of producing changes in its position. The *intrinsic muscles*, which are placed entirely within the substance of the tongue, are, for the most part, capable of giving rise to alterations in its form only.

Dissection.—With the exception of the chondro-glossus, the extrinsic muscles have been studied already, but the dissector should now take the opportunity of examining more fully their insertions, and the manner in which their fibres are related to one another and to those of the intrinsic muscles. To display the details, carefully reflect the mucous membrane from the right half of the tongue, and follow the muscles into that side of the organ. At the same time the lingual nerve and the profunda linguæ artery should be preserved. On the under surface of the tongue, near the tip, the removal of the mucous membrane will expose a group of glands, aggregated together so as to form a small oval mass on each side of the median plane. The mass of glands is known as the *apical gland* or the *gland of Nühn.*

The *stylo-glossus* will be seen running along the side of the tongue to the tip, where the muscles of opposite sides become, to a certain extent, continuous. The *hyo-glossus* extends upwards to the side of the tongue, and its fibres pass, for the most part, under cover of those of the stylo-glossus to reach the dorsum, over the posterior part of which they spread out, beneath the mucous membrane. The *genio-glossus* sends

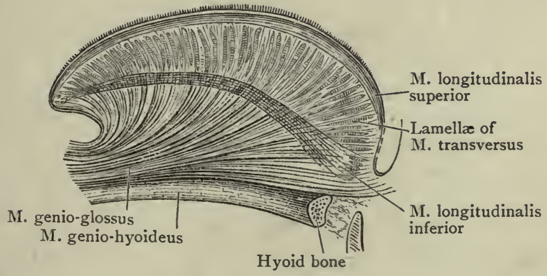


FIG. 133.—Longitudinal section through the Tongue. (From Aeby.)

its fibres upwards into the tongue on each side of the median septum, and its insertion stretches from the tip to the base. The fibres of the *glosso-palatinus* become continuous with the intrinsic transverse fibres.

The *chondro-glossus* is not always present. It is separated from the deep surface of the hyo-glossus by the lingual vessels. It is a slender muscular band which takes origin from the medial aspect of the root of the lesser cornu, and the adjoining part of the body of the hyoid bone. Its fibres ascend, to enter the tongue, where they finally spread out on the dorsum, under cover of the superior longitudinal muscle.

Musculus Longitudinalis Superior.—The superior longitudinal muscle lies immediately beneath the mucous membrane, and is a continuous layer of longitudinal fibres which covers the entire dorsum of the tongue, from the root to the tip. Towards the base of the tongue it is thinner than in front, and there it is overlapped by the transverse fibres of the hyoglossus, and is intermixed with the fibres of the chondro-glossus.

Musculi Longitudinales Inferiores.—The inferior longitudinal muscles are two rounded, fleshy bundles placed upon the inferior aspect of the tongue, one on each side. Posteriorly, each inferior longitudinal muscle lies in the interval between the hyo-glossus and the genio-glossus, and is attached to the hyoid bone; anteriorly, it is prolonged to the apex of the tongue between the medial border of the stylo-glossus and the genio-glossus; with the former it is more or less blended.

Musculus Transversus Linguæ.—The fibres of the transverse muscle lie under the superior longitudinal fibres, and

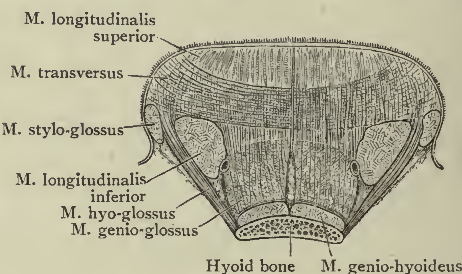


FIG. 134.—Transverse section through the Tongue. (From Aeby.)

constitute a thick layer which extends laterally, from the surface of the septum linguæ, to the side of the tongue. The fibres of the genio-glossus ascend through the transverse stratum and break it up into numerous lamellæ (Fig. 134). It is joined by the fibres of the glosso-palatinus (Henle) (Fig. 132).

Musculus Verticalis Linguæ.—The vertical fibres extend in a curved direction from the dorsum to the inferior aspect of the tongue, and decussate with the fibres of the transverse muscle.

Nerves and Vessels of the Tongue.—The nerves of the tongue are—(1) the glosso-pharyngeal; (2) the lingual; (3) the hypoglossal; and (4) a few twigs from the internal laryngeal. They should be traced on the left side of the tongue, where the mucous membrane is still in position.

The *glosso-pharyngeal nerve* has been traced up to the point where it disappears under cover of the hyo-glossus muscle. There it divides into two branches. The *smaller* of the two extends forwards, upon the side of the tongue, and may be traced as far as a point midway between the root and the tip. The *larger* branch turns upwards, and is distributed to the mucous membrane which invests the posterior third of the dorsum linguæ. It gives twigs to the vallate papillæ, and some fine filaments may be followed to the anterior surface of the epiglottis. The glosso-pharyngeal nerve is a nerve of taste and of common sensibility.

The *lingual* and *hypoglossal nerves* are described on pages 182 and 196, and their terminal branches should now be traced as far as is possible.

The *internal laryngeal nerve* gives a few delicate filaments to the glosso-epiglottic and pharyngo-epiglottic folds and the mucous membrane of the pharyngeal aspect of the tongue.

The *arteria profunda linguæ* should be followed to the tip of the tongue, where it forms a small loop of anastomosis with its fellow of the opposite side.

Septum Linguæ.—The septum of the tongue can be seen best in a transverse section through the organ. Such a section will also display, in a measure, the transverse and vertical muscular fibres. The septum is a median fibrous partition. It is strongest posteriorly, where it is attached to the hyoid bone. It does not reach the dorsum of the tongue, being separated from it by the superior longitudinal muscle.

ENCEPHALON—THE BRAIN.

Before the dissector commences the dissections of the brain he must be familiar with its main features and with the general arrangement of its parts. For this purpose he should obtain the half of a brain which has been divided by a median sagittal section, and from which the membranes have been removed, or a cast of such a specimen, and examine it from both its medial and its lateral sides (see Figs. 135, 136).

The brain is that portion of the central nervous system which lies in the cranial cavity, where it is surrounded by three membranes, the dura mater, which has already been examined (p. 99), and the arachnoid and the pia mater, which still cover the dissector's own specimen and which will be examined at a later stage.

The main part of the brain is formed by two somewhat hemispherical masses, called the *cerebral hemispheres*, which are so large, in the human subject, that when the brain is

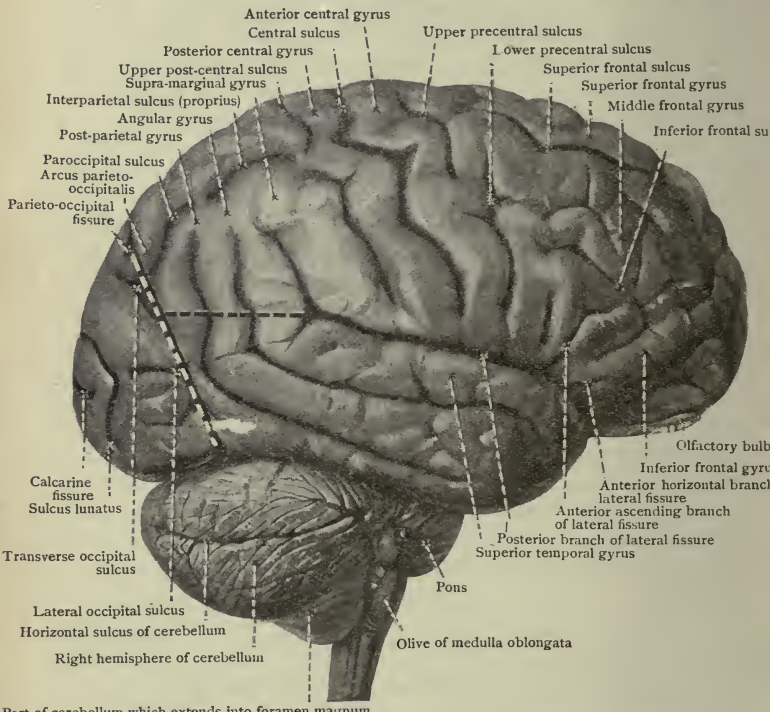


FIG. 135.—Lateral surface of Right Half of the Brain (semi-diagrammatic). The horizontal dotted line completes the separation between the parietal and temporal areas, and the oblique dotted line, which runs from the parieto-occipital fissure to the pre-occipital notch, separates the occipital from the parietal and temporal areas.

examined from above they entirely conceal all the other parts (Fig. 137).

The two hemispheres are connected together by—(1) a large transverse commissure called the corpus callosum (Fig. 136); (2) two smaller transverse commissures: (*a*) the transverse fibres of the fornix and (*b*) the anterior commissure; (3) by a thin membrane called the lamina terminalis, through which the fibres of the anterior commissure run (Figs. 136, 156, 159, 173).

The two hemispheres constitute, together, the *telencephalon*, which is the last formed, but the most highly developed, portion of the brain. Each hemisphere contains a cavity called the *lateral ventricle*, and there are, therefore, in the telencephalon two lateral ventricles, a right and a left, known also, though less commonly, as the first and the second (Figs. 163, 164, 165).

Immediately below and between the two cerebral hemispheres lies a portion of the brain called the *diencephalon.* It is continuous, posteriorly, with the mesencephalon or mid-brain, and, anteriorly and laterally, with the cerebral hemispheres. In the interior of the diencephalon there is a cavity called the third ventricle (Figs. 136, 168). The cavity is continuous, anteriorly, through apertures called the *interventricular foramina*, with the lateral ventricles of the telencephalon, and, posteriorly, with a canal, called the *aquæductus cerebri*, which runs through the mid-brain and connects the cavity of the diencephalon with that of the *rhombencephalon* or *hind-brain.*

When examined from its ventricular side, each half of the diencephalon is seen to be separated into two parts, a dorsal and a ventral, by an antero-posterior sulcus called the *sulcus hypothalamicus*; the dorsal part is called the *thalamus*, the ventral part is the *hypothalamus.* In Fig. 136 the point and the adjacent part of the arrow lie in the hypothalamic sulcus.

The dorsal wall of the cavity of the diencephalon is called the *roof of the third ventricle*, and from it a conical mass, called the *pineal body*, projects backwards over the mid-brain; it forms part of the *epithalamus.* The remainder of the epithalamus lies anterior and lateral to the pineal body, on the upper and posterior part of the thalamus, and it consists of the *habenula* and the *trigonum habenulæ*, on each side (Fig. 176).

Forming part of the ventral wall of the diencephalon are two round, white bodies, called the *corpora mamillaria*, and further forwards is a conical projection called the *tuber cinereum*, which is connected with the *hypophysis* by a thin stalk, called the *infundibulum* (Figs. 136, 139). All the parts of the ventral wall are parts of the hypothalamus.

Behind and somewhat below the diencephalon lies the mesencephalon or mid-brain. It is separable into—(1) a dorsal portion, the *lamina quadrigemina* or tectum, which is divided

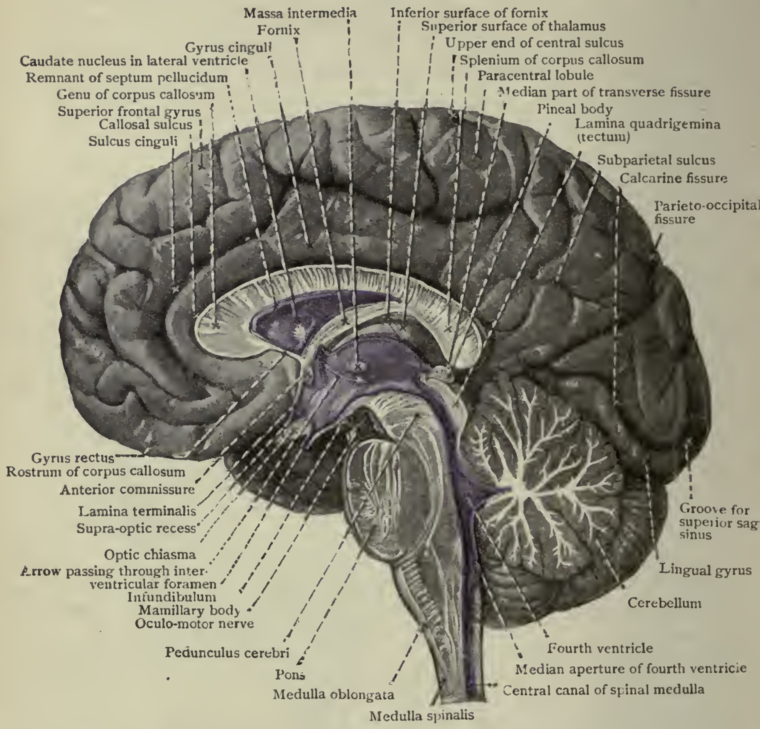


FIG. 136.—Medial surface of the Right Hemisphere, and the structures seen after a sagittal section has been made through the Corpus Callosum, the Fornix, the Diencephalon, the Mesencephalon, and the Rhombencephalon, and after the Septum Pellucidum has been removed from between the Corpus Callosum and the Fornix. The arrow passes through the interventricular foramen from the right lateral ventricle to the third ventricle, where it lies in the hypothalamic sulcus in the side wall of the third ventricle.

by a longitudinal and a transverse sulcus into four rounded bodies called the *colliculi* or *corpora quadrigemina* (Fig. 195); and (2) a ventral part, cut by a depression, the *interpeduncular fossa*, into two rounded columns, the *pedunculi cerebri*. The mid-brain is traversed, between the lamina quadrigemina and the pedunculi, by a canal, termed the aquæductus cerebri, which connects the third ventricle, in the diencephalon, with the fourth ventricle, in the hind-brain.

Still lower and more posteriorly—that is, below and behind the mid-brain—is the *rhombencephalon* or *hind-brain.* It also is separable into dorsal and ventral portions, and between them is the cavity of the hind-brain, called the *fourth ventricle* (Fig. 136). The dorsal portion is the *cerebellum*; it lies immediately below the posterior parts of the cerebral hemispheres and above and behind the fourth ventricle. The ventral part of the hind-brain consists of an upper part, called the *pons*, which is continuous with the pedunculi of the mid-brain, and a lower part, called the *medulla oblongata*, which is continuous, below, with the spinal medulla.

When the brain was removed, the dissector noticed that the cerebral hemispheres occupied the anterior and middle fossæ of the cranium and that, more posteriorly, they lay on the tentorium cerebelli—a fold of dura mater which separated them from the hind-brain (Figs. 32, 35). The dissector noted also, after the removal of the tentorium cerebelli, that the hind-brain occupied the posterior fossa of the cranium, and that the mid-brain passed from the posterior fossa to the middle fossa through an oval notch, the incisura tentorii.

The brain is surrounded by three membranes—the dura mater, the arachnoid, and the pia mater; and between the arachnoid and the pia mater lie the main trunks of the blood vessels of the brain.

The dura mater was examined during and after the removal of the brain from the cranial cavity (pp. 99-102); but, before the arachnoid, the pia mater, and the blood vessels which lie between them, are studied, the dissector must be acquainted, not only with the main subdivisions of the brain, but he must have also a good knowledge (1) of the names of the fissures and sulci of the cerebral hemispheres, (2) of the names and positions of their various borders, surfaces, and lobes, and (3) of the position of the cerebral nerves. He should, therefore, obtain a brain from which the membranes have been detached and in which the mid-brain has been divided horizontally so that the lower part of the mid-brain and the hind-brain can be removed. He should obtain also a cerebral hemisphere which has been separated from its fellow of the opposite side and from the mid-brain, and from which the membranes have been removed.

If actual specimens cannot be obtained good casts will serve the present purpose.

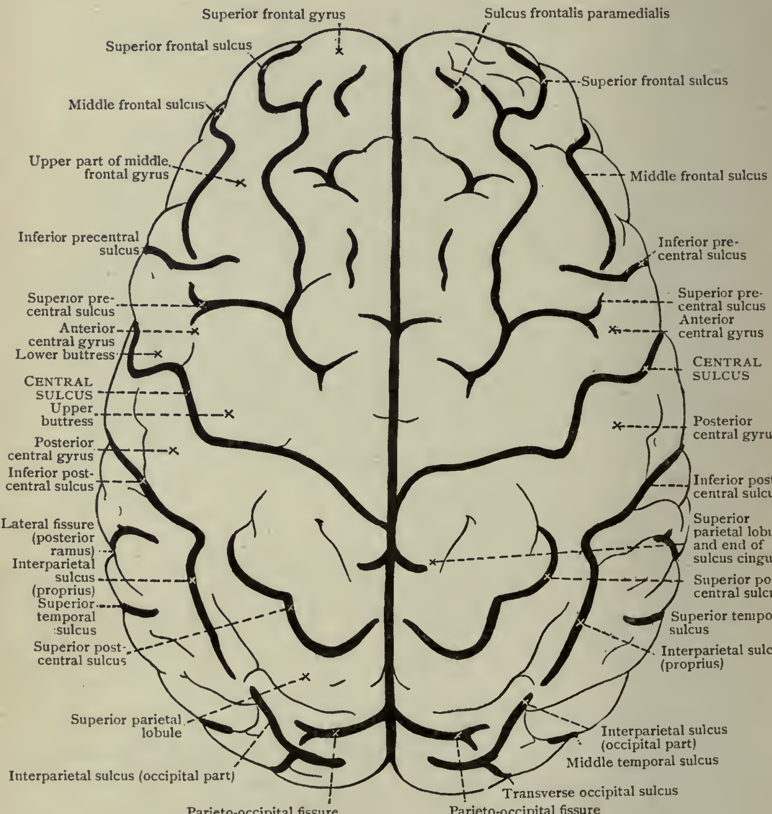


FIG. 137.—View of the Hemispheres from above (semi-diagrammatic).

Having obtained the specimens, he must examine them from above, from below, from the lateral and the medial sides; and he should commence the inspection by examining the upper aspects of the specimens. As he does that he will note the difference between the blunt and rounded anterior end, which is called the *frontal pole*, and the more pointed posterior end, called the *occipital pole*, and he cannot fail to note that the surface of each hemisphere, at which he is looking, is convex and is directed upwards and laterally, and may therefore be termed the *supero-lateral surface*, and he will note, further, that it is moulded into numerous curved ridges of cerebral substance. The ridges are called *gyri*, and they are separated more or less completely from one another by narrow depressions, some of which are called *sulci* and others *fissures*. All the fissures and some of the sulci are named, but there are many small unnamed sulci.

A mere glance will convince the dissector that the majority of the gyri, at which he is looking, run antero-posteriorly, but that two gyri on each side, which lie a little posterior to the centre of the antero-posterior length of the hemispheres, have an entirely different direction; they run obliquely from below upwards and backwards. They form, therefore, distinct landmarks; they are known as the *anterior* and *posterior central gyri*, and the cleft which lies between them is called the *central sulcus* (Figs. 135, 137) (O.T. fissure of Rolando); in the majority of cases its upper end cuts the upper or *supero-medial border* of the hemisphere.

Between the upper end of the central sulcus and the occipital pole of the hemisphere, but nearer the latter than the former, a deep cleft cuts the supero-medial border of the hemisphere, and extends for a short distance, laterally, on the supero-lateral surface; it is the lateral part of the *parieto-occipital fissure* (Fig. 137).

The dissector should, if possible, insert the brain, or the model with which he is working, into a sagittal section of a skull of convenient size, and note that the upper end of the central sulcus corresponds with a point on the vertex of the skull which lies 12 *mm.* (*half an inch*) *behind* the centre point between the root of the nose and the external occipital protuberance, the nasion and the inion respectively, and that the parieto-occipital fissure is placed about 6 *mm. in front of* the lambda.

When the dissector has satisfied himself regarding the points mentioned, he should examine the supero-lateral surface of the hemisphere from the lateral side. Again he will note the general antero-posterior direction of the gyri and sulci, and the markedly different direction of the central sulcus and the anterior and posterior central gyri. He will note also that, immediately below the lower end of the central sulcus, more rarely continuous with it, there is a very well-marked antero-posterior cleft; it is the posterior ramus of the *lateral fissure* (Sylvian) (Fig. 135). The lateral fissure commences on the inferior surface of the hemisphere (Fig. 138), and divides, immediately after it reaches the lateral surface, into anterior horizontal, anterior ascending, and posterior rami, all of which the dissector must identify (Figs. 135, 152). The posterior ramus is always easily identified, but the anterior rami may present difficulty.

The part of the hemisphere which lies below the lateral fissure is the anterior part of the temporal lobe; it ends anteriorly in a rounded point called the *temporal pole.*

The dissector should next turn his attention to the borders of the hemisphere as seen from the lateral side (Fig. 135). They are *supero-medial*, *infero-lateral*, and *superciliary.*

The *supero-medial border* is convex. It extends from the *frontal pole* to the *occipital pole*, along the side of the superior sagittal venous sinus, and separates the supero-lateral surface from the medial surface.

The *infero-lateral border* is concavo-convex. It extends from the occipital to the temporal pole. Its posterior and larger part lies along the line of the transverse venous sinus, and its anterior part runs along the line of the petro-squamous suture. It separates the supero-lateral surface from the posterior part of the inferior surface of the hemisphere. On this border, about a third of its length from the occipital pole, there is a distinct notch, called the *pre-occipital notch*, caused by the terminal portion of a vein which descends on the hemisphere to the transverse sinus.

The *superciliary border* extends from the temporal pole to the frontal pole. It corresponds in position, anteriorly, with the superciliary arch of the skull, and it separates the supero-lateral surface from the anterior or orbital part of the inferior surface. The dissector should verify the above statements by placing his specimen, if possible, in sagittal and horizontal sections of skulls of convenient size.

For purposes of description and localisation the greater part of each hemisphere is divided, by means of fissures and sulci, into areas called lobes, and within the area of each lobe there are, as a rule, several gyri.

Portions of four of the lobes, the *frontal*, the *parietal*, the *occipital* and the *temporal*, are visible on the supero-lateral surface.

The **frontal lobe** lies anterior to the central sulcus and above the stem and the anterior part of the posterior ramus of the lateral fissure. In it, immediately anterior to the central sulcus, is the *anterior central gyrus*, in which is the motor area of the cerebral cortex (Fig. 153). The anterior central gyrus is partially separated from the more anterior part of the frontal lobe by a *precentral sulcus*, which is generally divided into upper and lower portions. Anterior to the pre-central sulcus there are three gyri which run antero-posteriorly ; they are named from above downwards, the *superior*, *middle*, and *inferior frontal gyri* (Figs. 135, 137).

The dissector should note—(1) that the anterior horizontal and anterior ascending rami of the lateral fissure cut into the inferior frontal gyrus ; and (2) that, whilst the frontal lobe is partly covered by the frontal bone, a considerable part of its posterior portion, including the anterior central gyrus and the posterior parts of the antero-posterior gyri, is under cover of the anterior part of the parietal bone (Fig. 177).

The **parietal lobe** is bounded, anteriorly, by the central sulcus ; posteriorly, by the parieto-occipital fissure and a line prolonged from it to a notch (Fig. 135) on the infero-lateral border called the *pre-occipital notch* ; inferiorly, by the posterior ramus of the lateral fissure, and a line prolonged backwards from the point where that fissure turns from a horizontal to a vertical direction to the line from the parieto-occipital fissure to the pre-occipital notch. The supero-lateral surface of the parietal lobe is separated into three main areas. Immediately posterior to the central sulcus is the *posterior central gyrus*. It is bounded, posteriorly, by the *post-central sulcus*, and it is the region of ordinary sensation (Fig. 153). Behind the post-central sulcus the parietal lobe is separated into an *upper* and a *lower parietal lobule*, by an antero-posterior sulcus called the *sulcus interparietalis proprius*.

The **occipital lobe** lies behind the parieto-occipital fissure and the line which connects that fissure with the pre-occipital notch. Its surface is divided into four areas by three sulci. The area in the region of the occipital pole is marked off by a curved sulcus, concave backwards, called the *sulcus lunatus*. The larger anterior part is divided by two antero-posterior sulci, called the *lateral occipital sulcus* and *paramedial occipital sulcus*, into three gyri—the superior, middle, and inferior.

The lateral surface of the **temporal lobe** is divided by two sulci, which run antero-posteriorly, into superior, middle, and inferior temporal gyri.

When the survey of the supero-lateral surface is completed, a specimen should be examined in which the lips of the lateral fissure have been separated or removed. In such a specimen it will be obvious that at the bottom of the fissure there is a sunken area of the brain cortex (Fig. 157). It is called the **insula**, and it is separated from the adjacent parts by a sulcus called the *circular sulcus.*

After the general relations of the supero-lateral surface have been noted the medial surface of the hemisphere should be examined. Upon it, nearer its anterior than its posterior end, and nearer its lower than its upper border, will be seen the surface of section of the severed *corpus callosum* (Fig. 136).

The corpus callosum consists of a *trunk*, which terminates posteriorly in a free, thick, rounded posterior end, called the *splenium*, and anteriorly in a bent anterior extremity called the *genu.* From the genu a tapering portion of the corpus callosum, termed the *rostrum*, passes downwards and backwards. It ends below in a thin lamina, called the *lamina terminalis*, which descends till it reaches the ovoid transverse section of the *optic chiasma*, which connects together the two optic nerves. The lamina terminalis passes behind the optic chiasma, and joins the tuber cinereum in the floor of the third ventricle (Figs. 136, 159). The transverse, small and round, white bundle which passes through the lamina terminalis, above the optic chiasma, is the anterior commissure.

In the median plane, in the angle between the body, genu, and rostrum of the corpus callosum, there is a thin vertical lamina called the *septum pellucidum.* It is bounded below and behind by a flat band of white matter, called the *fornix* (Figs. 136, 156).

The boundaries of the medial surface of the hemisphere are—(1) The *supero-medial border*, which extends from the frontal pole to the occipital pole, and separates the medial from the supero-lateral surface. (2) The *medial occipital border*, which extends from the occipital pole to the splenium of the corpus callosum; it separates the medial surface from the posterior part of the inferior surface. (3) The *medial* *orbital border*, which runs from a point immediately in front of the optic chiasma to the frontal pole, separating the medial surface from the anterior part of the inferior surface.

Between the medial occipital and the medial orbital borders the lower boundary of the medial surface is formed by the lower margin of the splenium and the lower margin of the fornix, which lie immediately above the diencephalon.

The corpus callosum is separated from the *gyrus cinguli*, which is immediately adjacent to it, by the *callosal sulcus* (Fig. 136).

The gyrus cinguli is separated from the adjacent parts of the medial surfaces of the frontal and parietal lobes by the *sulcus cinguli*, which turns upwards at its posterior end, and cuts the supero-medial border of the hemisphere, a short distance behind the upper end of the central sulcus (Figs. 136, 156).

Some distance in front of its posterior end, the sulcus cinguli gives off a branch which ascends towards the supero-medial border. That branch is not named but it lies parallel with, or slightly in front of, the pre-central sulcus on the supero-lateral surface of the hemisphere. The portion of the medial surface of the hemisphere which lies between the posterior end of the sulcus cinguli and the unnamed upturned branch, corresponds in a general way with the upper ends of the posterior and anterior central gyri, and it is termed the *paracentral lobule* (Figs. 136, 159).

The part of the medial surface above the sulcus cinguli and between the frontal pole and the paracentral lobule is the medial part of the superior frontal gyrus; and the part which extends from the frontal pole to the optic chiasma, below the sulcus cinguli, is the *gyrus rectus*, which will be seen also on the inferior surface.

Behind the upturned, posterior end of the sulcus cinguli, but in direct line with its main portion, is a small separate sulcus, called the *subparietal sulcus*; and cutting the supero-medial border of the hemisphere about a fourth of its length from the occipital pole is the *parieto-occipital fissure*, which crosses the posterior part of the medial surface. The lower end of the parieto-occipital fissure joins an important fissure called the *calcarine* at an acute angle. That part of the medial surface which lies above the sub-parietal sulcus, and between the parieto-occipital fissure and the upturned end of the sulcus cinguli, is termed the *præcuneus*; it is the medial part of the superior parietal lobule.

Cutting the supero-medial border a short distance above the occipital pole is the *calcarine fissure*. It is a deep fissure

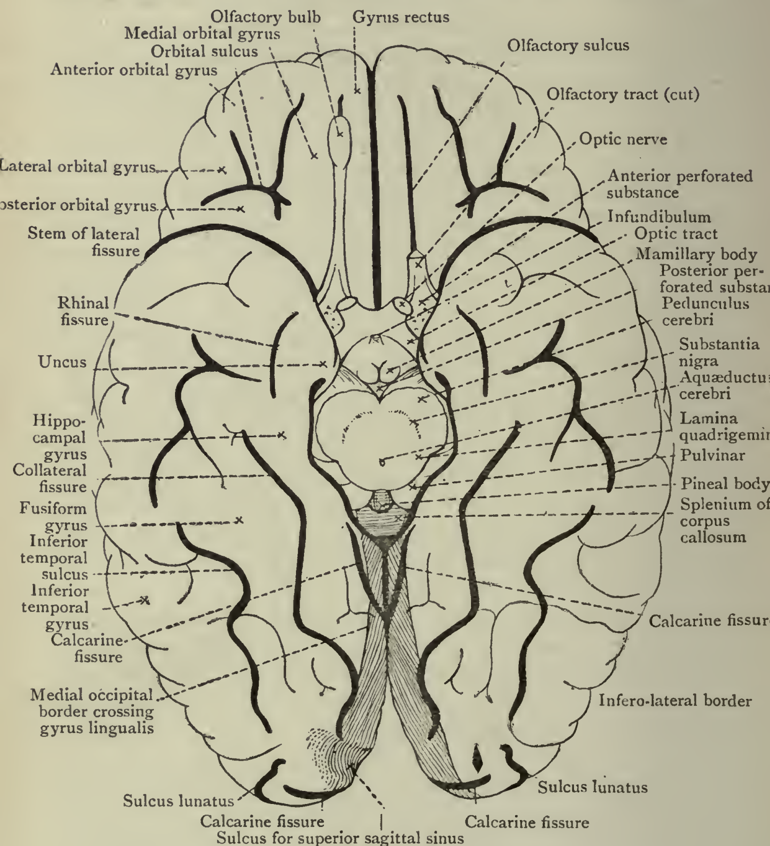


FIG. 138.—Inferior surfaces of Hemispheres (semi-diagrammatic).

which runs forwards on the medial surface. It turns downwards across the anterior part of the medial occipital border and at that point it is joined by the parieto-occipital fissure. Then it runs obliquely downwards and forwards in the posterior part of the inferior surface below the splenium of the corpus callosum. The wedge-shaped region of the cortex of the hemisphere between the calcarine fissure and the parieto-occipital fissure is called the *cuneus*; and the portion of the medial surface of the hemisphere below the calcarine fissure is the posterior portion of the *lingual gyrus*, the remainder of which is on the inferior surface. Both the cuneus and the lingual gyrus are parts of the occipital lobe.

In the majority of cases the posterior part of the medial surface of the occipital lobe is marked by a definite vertical depression caused by the posterior part of the superior sagittal sinus (Fig. 154).

After the examination of the medial surface is completed, the dissector should examine the lower surface of a specimen from which the hind-brain and the lower part of the mid-brain have been removed (Fig. 138).

Upon each side he will note the three poles of the corresponding hemisphere—frontal, temporal, and occipital.

The part anterior to the temporal pole is the anterior part of the inferior surface, and at the same time it is the inferior surface of the frontal lobe.

It is bounded, anteriorly and laterally, by the superciliary border; medially, by the medial orbital border; and, posteriorly, in the lateral and greater part of its extent, by the stem of the lateral fissure, which separates it from the temporal lobe, but the medial part of its posterior boundary is a sulcus which intervenes between it and a small triangular area at the side of the optic chiasma, called the *anterior perforated substance.* Lying parallel with the medial orbital border is a sulcus, the *olfactory sulcus*, in which the olfactory bulb and the olfactory tract are lodged. The gyrus which lies to the medial side of the olfactory sulcus is the *gyrus rectus*, already seen on the medial surface of the hemisphere. The portion of the surface which lies lateral to the olfactory sulcus is concave, the concavity being due to the upward projection of the roof of the orbit on which it rests, and the gyri of this area are called orbital gyri. As a rule, there are four *orbital gyri*, a medial, a lateral, an anterior, and a posterior; they are separated from one another by a series of sulci, the *orbital sulci*, which have, collectively, an H-shaped outline.

The posterior part of the inferior surface, which lies behind the temporal pole, looks downwards and medially, when the brain is in position in the cranium. It rests, in the posterior part of its extent, upon the tentorium cerebelli, and, more anteriorly, upon the anterior surface of the petrous

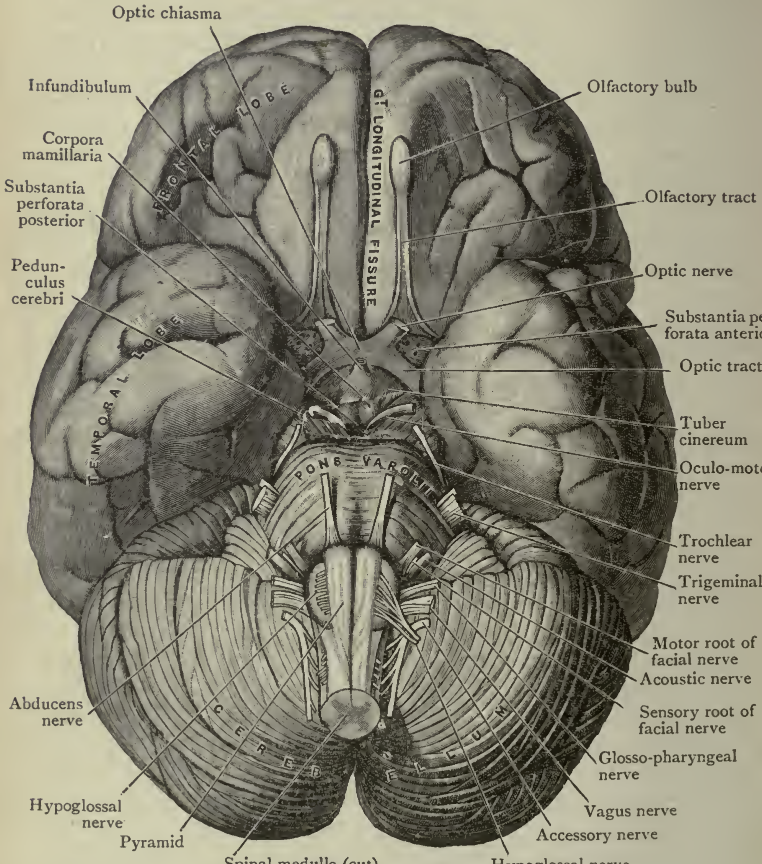


FIG. 139.—The Base of the Brain with the Cerebral Nerves attached.

portion of the temporal bone and the great wing of the sphenoid. On account of its relation to the tentorium, it is frequently called the *tentorial surface.*

The posterior part of the inferior surface is bounded anteriorly by the temporal pole, posteriorly by the occipital pole; laterally by the infero-lateral border, which separates it from the supero-lateral surface; medially, in the posterior part of its extent, by the medial occipital border, which separates it from the medial surface, and, more anteriorly, by a fissure called the chorioidal fissure, which lies between it and the sublentiform portion of the hemisphere.

Upon the part which rests upon the petrous portion of the temporal bone, a short distance posterior to the temporal pole, will be seen a depression produced by the eminentia arcuata of the temporal bone. The part of the brain cortex which lies immediately antero-lateral to the depression rests, in the ordinary position, on the tegmen tympani and the petro-squamous suture. It lies, therefore, immediately above the epi-tympanic recess or attic of the tympanic cavity, from which it is separated merely by its membranes and a very thin plate of bone.

Crossing the medial occipital border, a short distance posterior to the corpus callosum, is the stem or anterior part of the *calcarine fissure*, already mentioned. It runs forwards for a short distance on the posterior part of the inferior surface. The part of the cortex between it and the splenium of the corpus callosum is the *isthmus*; it is continuous, above, with the gyrus cinguli, and, below, with the *hippocampal gyrus*. The hippocampal gyrus runs forwards and its anterior end turns upwards forming a hook-shaped bend, called the *uncus*. The posterior part of the hippocampal gyrus is termed the *paradentate area* (Fig. 156), and the anterior part is known as the *piriform area*. Continuous with the paradentate area, but lying posterior to it and below the stem of the calcarine fissure, is the *lingual gyrus*, which runs backwards and turns round the medial occipital border to the medial surface of the occipital lobe, where it was previously noted. Lateral and anterior to the piriform area, and on a lower plane, is a small but definite fissure, called the *rhinal fissure*, and posterior to the rhinal fissure and lateral to the paradentate area and the lingual gyrus, on a lower plane, is a definite sulcus, which runs antero-posteriorly, and is called the *collateral fissure*. The gyrus which lies below and lateral to the collateral fissure has been termed the *fusiform gyrus*; it is also called the occipito-temporal gyrus. Between it and the infero-lateral border lies the inferior temporal sulcus, which separates it from the inferior part of the inferior temporal gyrus (Fig. 138).

When the survey of the inferior surfaces of the cerebral hemispheres is completed, the inferior aspect of a brain, or a cast, in which the mid- and hind-brain sections are still *in situ*, or in which they can be replaced, should be examined.

When that is done it will be noted that the posterior sections of the inferior surfaces of the hemispheres are concealed by the cerebellum, but the more anterior parts of the inferior surfaces are still visible. Between the anterior parts of the inferior surfaces, in the median plane, is the anterior part of the longitudinal fissure. Behind the anterior part of the longitudinal fissure lies the *optic chiasma*, but if the chiasma is carefully turned backwards, the lamina terminalis will be seen passing upwards and forwards into the longitudinal fissure (Fig. 162). At its antero-lateral angles the optic chiasma receives the optic nerves, and from each postero-lateral angle it gives off an optic tract, which runs postero-laterally and disappears from view under cover of the piriform area.

Behind the optic chiasma is the tuber cinereum with the infundibulum projecting from its apex to connect it with the hypophysis. Behind the tuber cinereum lie two round white bodies called the corpora mamillaria, and still more posteriorly is the deepest part of the *interpeduncular fossa*, which lies between the medial borders of the pedunculi cerebri. The superior boundary of the interpeduncular fossa is the *posterior perforated substance*.

The pedunculi cerebri run upwards, forwards and laterally, at the sides of the interpeduncular fossa. The upper end of each disappears into the base of the corresponding hemisphere, and its lower end is continuous with the pons of the hind-brain.

Springing from the medial side of each pedunculus is the corresponding oculo-motor nerve, and curving round its lateral side is the trochlear nerve.

Below the pedunculi cerebri of the mid-brain is the *pons* of the hind-brain, which is connected, on each side, with the corresponding hemisphere of the cerebellum.

Springing from each side of the pons, immediately medial to the corresponding hemisphere of the cerebellum, are the motor root and sensory root of the trigeminal nerve of that side.

Below the pons, in the vallecula between the hemispheres of the cerebellum, is the *medulla oblongata.* Springing from the sulcus between the medulla oblongata and the pons, are the abducens, the facial, and the acoustic nerves, in that order from the median plane to the lateral border, on each side.

The medulla oblongata is cleft, in the median plane, by an anterior longitudinal fissure which is bounded, on each side, by a longitudinal elevation called a *pyramid.* At the lateral side of the upper part of each pyramid is an oval prominence called the *olive*, and between the olive and the pyramid lie the fila of the *hypoglŏssal nerve*; whilst attached to the sides of the medulla oblongata, a little dorsal to the olive, are the fila of the glosso-pharyngeal, the vagus, and the accessory nerves, in that order from above downwards.

At the sides of the pons and the medulla oblongata are the inferior surfaces of the hemispheres of the cerebellum.

When the positions of the fila of origin of the cerebral nerves have been noted, the hind-brain and the lower part of the mid-brain should be removed. When that has been done the posterior sections of the inferior surfaces of the hemispheres will be exposed. They are separated from each other, posteriorly, in the median plane, by the posterior part of the longitudinal fissure, but they are united, more anteriorly, immediately dorsal to the anterior part of the mid-brain, by the splenium of the corpus callosum (Fig. 138).

When the points mentioned above have been verified the dissector should examine the dorsal aspect of the hind-brain, which is formed by the cerebellum, and he should note that it is separable into two hemispheres united by a median ridge called the *superior vermis.* The antero-posterior length of the superior vermis is not so great as the antero-posterior length of the hemispheres; therefore the hemispheres are separated, anteriorly, by an *anterior notch* and, posteriorly, by a *posterior notch.*

The dissector should terminate his inspection of the general features of the brain by gently separating the medulla oblongata from the inferior aspect of the cerebellum, if he is dealing with a specimen and not a cast; when he has done that, he will be able to convince himself that the roof of the cleft or *vallecula*, in which the medulla oblongata lies, is formed by the inferior part of the middle portion of the cerebellum, which projects downwards into the vallecula, and is called the *inferior vermis*.

When the inspection of specimens from which the membranes have been removed is finished, the dissector should turn to the examination of the membranes which still cover his own specimen; they are the arachnoid and the pia mater.

Arachnoidea Encephali.—The arachnoid forms an intermediate covering for the brain. It is placed between the dura mater and the pia mater; it is directly continuous with the arachnoid of the spinal medulla; and it is connected with the dura mater and the pia mater along the nerve roots and along the blood vessels of the brain. It is an exceedingly thin and delicate membrane, which can be seen best on the base of the brain, because, in that locality, it is not so closely applied to the pia mater as elsewhere. Unlike the pia mater it does not (except in the case of the longitudinal and the lateral fissures) dip into the sulci or fissures on the surface of the cerebrum and cerebellum. It bridges over the inequalities on the surface of the brain and it is spread out in the form of a very distinct sheet over the medulla oblongata, the pons, and the hollow on the lower surface of the brain which lies anterior to the pons. The cut ends of several of the cerebral nerves will be seen passing through the arachnoid; whilst, anteriorly, immediately to the lateral side of the optic nerve, the internal carotid artery will be noticed piercing it.

Cavum Subarachnoideale.—The interval between the arachnoid and the pia mater receives the name of the subarachnoid space. It contains the subarachnoid fluid, and is broken up by a meshwork of fine filaments and trabeculæ, which connect the two bounding membranes (viz., the arachnoid and the pia mater), in the most intimate manner, and which form a delicate sponge-like interlacement between them. Where the arachnoid passes over the summit of a cerebral gyrus, and is consequently closely applied to the subjacent pia mater, the meshwork is so close and the trabeculæ so short that the two membranes cannot be separated from each other. To the dissector they appear to form a single lamina. In the intervals between the rounded margins of adjacent gyri distinct angular spaces exist between the arachnoid and the pia mater. In those spaces the subarachnoid tissue can be studied, and it will be seen that the spaces serve as communicating channels for the free passage of the subarachnoid fluid from one part of the brain to another. The larger branches of the arteries and veins of the brain traverse the subarachnoid space; their walls are directly connected with the subarachnoid trabeculæ and are bathed by the subarachnoid fluid.

Cisternæ Subarachnoideales.—In certain situations the arachnoid is separated from the pia mater by intervals of considerable depth and extent. Such expansions of the subarachnoid space are termed subarachnoid cisterns. In them the subarachnoid tissue is relatively reduced. There

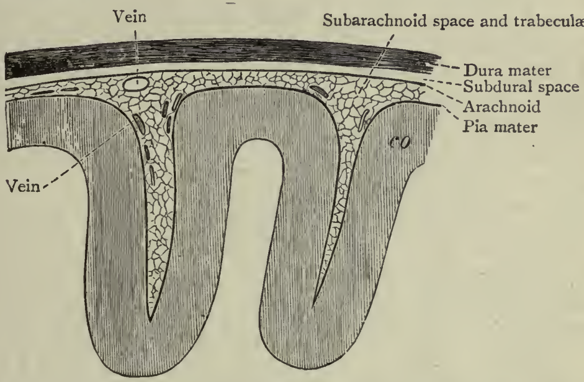


FIG. 140.—Diagrammatic section through the Meninges of the Brain. (Schwalbe.)

co. Grey matter of cerebral gyri.

is no longer a close meshwork; the trabeculæ connecting the two bounding membranes take the form of long filamentous intersecting threads which traverse the spaces. The dissector will obtain a beautiful demonstration of the conditions described by dividing the sheet of arachnoid which is spread over the medulla oblongata and pons, and turning the two pieces gently aside. The division must be made in the median plane with scissors.

Certain of the cisternæ require special mention. The largest and most conspicuous is called the *cisterna cerebellomedullaris* (O.T. *magna*) (Fig. 141). It is a direct upward continuation of the posterior part of the subarachnoid space of the spinal meninges into the posterior part of the cranium. It is formed by the arachnoid membrane bridging over the wide interval between the medulla oblongata and the posterior part of the inferior surface of the cerebellum.

The *cisterna pontis* is the name given to another of the subarachnoideal spaces. It is the continuation upwards, on the floor of the cranium, of the anterior part of the sub-

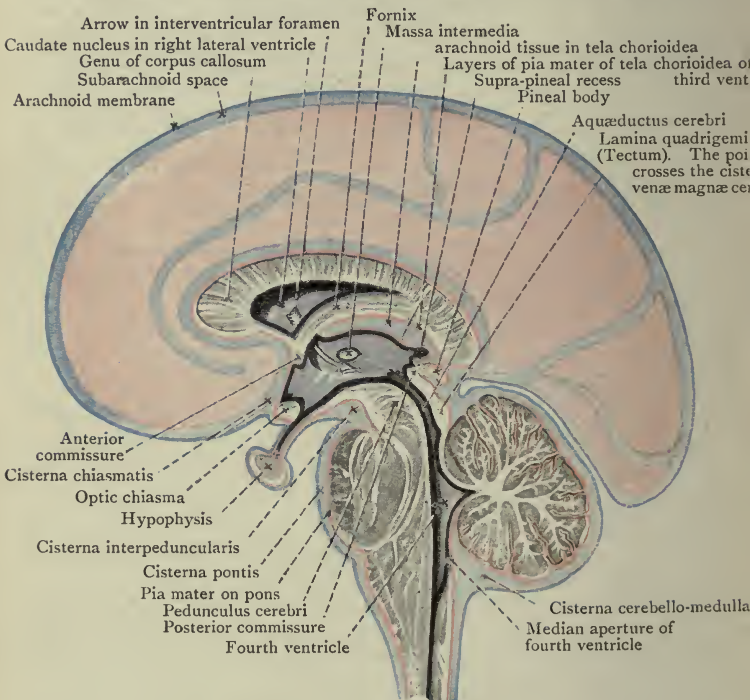


FIG. 141.—Diagram showing some of the Subarachnoid Cisternæ. Dark blue line indicates arachnoid membrane. Pale blue, subarachnoid tissue containing cerebro-spinal fluid. Dark red indicates cut margin of pia mater. Pale red, surface of pia mater from which arachnoid has been removed. Purple indicates epithelial lining of the cavities of the brain.

arachnoid space of the spinal meninges. In the region of the medulla oblongata it is continuous, on each side, with the cerebello-medullary cistern, so that that subdivision of the brain is completely surrounded by a wide subarachnoid space. Within the cisterna pontis are the vertebral and basilar arteries.

Anterior to the pons the arachnoid membrane crosses between the projecting temporal lobes, and covers in the deep hollow in that region of the base of the brain. The space so enclosed is called the *cisterna interpeduncularis*, and within it are placed the large arteries which take part in the formation of circulus arteriosus. The cisterna interpeduncularis is continuous, anteriorly, with the *cisterna chiasmatis*, which lies anterior to the optic chiasma and lodges the anterior cerebral arteries (Fig. 141).

All the subarachnoid cisterns communicate in the freest manner with one another, and also with the narrow subarachnoid intervals on the surface of the cerebrum. The subarachnoid space does not communicate in any way with the subdural space. In certain localities, however, it communicates with the ventricular system of the brain by small apertures. Three such apertures are described in connection with the fourth ventricle, whilst another slit, on each side, is said to lead from the cisterna interpeduncularis into the lower and anterior end of the corresponding inferior horn of the lateral ventricle.

Extending laterally from the cisterna interpeduncularis, on each side, is the *cisterna fossæ lateralis cerebri*, which runs along the stem of the lateral fissure into the lateral fossa, which is the recess in which the insula lies. In it lie the middle cerebral vessels. Anteriorly, the cisterna chiasmatis is continuous with a prolongation which extends into the longitudinal fissure along the anterior cerebral vessels. A dilatation of the subarachnoid space over the dorsum of the mid-brain, around the great cerebral vein (O.T. vena magna Galeni), is called the *cisterna venæ magnæ cerebri*.

The cisterna venæ magnæ cerebri was opened when the mid-brain was divided, during the removal of the brain. The dissector should now examine the other cisternæ by carefully dividing the arachnoid, where that has not already been done.

Dissection.—Divide the arachnoid, in the median plane, along the anterior surfaces of the medulla oblongata and the pons (if the division has not been made previously), and turn the flaps to the sides. When that has been done the upper ends of the vertebral arteries, and the basilar artery, which is formed by their union, will be exposed, lying in the cisterna pontis.

Carry an incision backwards and laterally, through each flap of arachnoid, into the angle between the medulla oblongata and the posterior part of the inferior surface of the cerebellum, and so open the large cisterna cerebello-medullaris. It lies between the inferior vermis of the cerebellum and the dorsal surface of the medulla oblongata, and it communicates, through the thin dorsal wall of the medulla oblongata, with the cavity of the hind-brain, which is called fourth ventricle. Note that a large branch of each vertebral artery, called the posterior inferior cerebellar, passes into the cerebello-medullary cistern, on its way to its distribution to the posterior part of the inferior aspect of the cerebellum.

Turn again to the lower surface of the pons, and carry the median incision in the arachnoid, forwards, into the interpeduncular region, as far as the posterior border of the infundibulum, and so open the cisterna interpeduncularis. Note that the arachnoid which forms the floor or inferior wall of the interpeduncular cistern is perforated posteriorly, on each side, by the oculo-motor nerve, and anteriorly and more laterally by the internal carotid artery.

Take away the arachnoid which forms the lower wall of the cisterna interpeduncularis, and so expose the basilar artery as it terminates in its two posterior cerebral branches. Find also the two posterior communicating arteries, which run forwards, one on each side, from the corresponding posterior cerebral artery, to join the internal carotid arteries, which enter the antero-lateral angles of the cisterna interpeduncularis.

Draw the optic chiasma carefully backwards and cut through the arachnoid immediately in front of it, to open the cisterna chiasmatis. Carry the incision in the arachnoid of the cisterna chiasmatis laterally, round the lateral borders of the optic chiasma, and note that the cisterna chiasmatis communicates, round the margins of the chiasma, with the cisterna interpeduncularis. Take away the arachnoid which has already been divided, and note that beyond the lateral borders of the optic chiasma, both the cisterna interpeduncularis and the cisterna chiasmatis are prolonged laterally, on each side, between the frontal and the temporal regions of the brain, into the stem of the lateral fissure.

Clean the internal carotid arteries as they lie at the sides of the optic chiasma, and note—(1) that each communicates with the corresponding posterior cerebral artery by means of the posterior communicating artery; (2) the division of each internal carotid into a middle and an anterior cerebral branch. The middle cerebral branch runs laterally into the stem of the lateral fissure, and the anterior cerebral turns medially above the optic chiasma, in the cisterna chiasmatis, to reach the longitudinal fissure, into which it passes; but as it enters the fissure it is connected with its fellow of the opposite side by the anterior communicating artery.

It is not advisable to follow the cerebral arteries further at this stage.

Granulationes Arachnoideales (O.T. **Pacchionian Bodies**).—The connection of the arachnoideal granulations with the arachnoid has been referred to already (p. 100).

Pia Mater Encephali.—The pia mater forms the immediate investment of the brain. It is finer and more delicate than the corresponding membrane of the spinal medulla, and it follows closely all the inequalities on the surface of the brain. Thus, in the case of the cerebrum, it forms a fold within every sulcus and lines both sides of the cleft. On the cerebellum the relation is not so intimate; it is only the larger fissures of the cerebellum which contain folds of pia mater.

It has been noted that the larger blood vessels of the brain run in the subarachnoid space; the finer twigs enter the

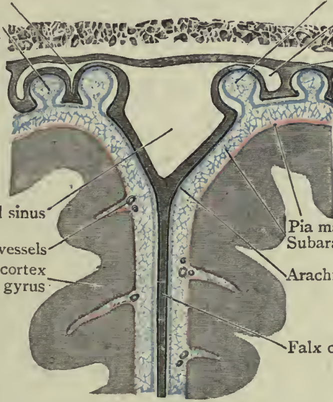


FIG. 142.—Diagram of a frontal section through the middle portion of the cranial vault and subjacent brain to show the membranes of the brain and the arachnoideal granulations.

pia mater, where they ramify and anastomose before passing into the substance of the brain. As they enter the brain they carry with them sheaths derived from the pia mater. Consequently, if the dissector raises a portion of that membrane from the surface of the cerebrum, a number of fine processes will be seen to be withdrawn from the cerebral substance. They are the blood vessels, and they give the deep surface of the membrane a rough and flocculent appearance.

The pia mater is not confined to the exterior of the brain. A fold is carried into its interior. This will be exposed in the dissection of the brain, and will be described under the name of the tela chorioidea (O.T. velum interpositum) of the third ventricle (Fig. 174).

BLOOD VESSELS OF THE BRAIN.

The dissector should commence his study of the blood vessels of the brain by an inspection of the veins of the brain. He will readily find and easily follow some of the venous blood channels, but he will have considerable difficulty in tracing others from their commencements to their terminations. Indeed, it may be that he will have to refer to specially prepared specimens for confirmation of some of the points about to be noted.

The Veins of the Brain.—The venous channels of the brain include the venous blood sinuses of the dura mater, and the veins which open into them. The venous sinuses were noted when the dura mater was studied after the removal of the brain (pp. 113, 114, 115).

Veins of the Cerebral Hemispheres.—The veins which join the venous sinuses of the dura mater, and their tributaries are still *in situ*. The majority of them lie in the subarachnoid space on the surfaces of the hemisphere, but a few issue from the interior of the brain. One of the latter, the *great cerebral vein*, was seen when the upper parts of the brain were removed from the cranium (p. 108). It emerges from beneath the splenium of the corpus callosum, and runs upwards and backwards, in the cistern of the great cerebral vein, to terminate by joining the anterior end of the straight sinus in the tentorium cerebelli (p. 107, Fig. 35). The cut end of it can still be seen lying in the cistern, immediately posterior to the splenium of the corpus callosum.

Entering the great cerebral vein on each side is a tributary called the basal vein; it runs round the side of the pedunculus cerebri, from the region of the anterior perforated substance. The basal vein is formed, in the subarachnoid space below the anterior perforated substance, by the union of three veins, viz., (1) the anterior cerebral vein with (2) a vein from the surface of the insula, called the *deep middle cerebral vein*, and (3) the *anterior striate vein*, which issues from the substance of the brain. The *anterior cerebral vein* drains the greater part of the medial surface of the hemisphere of the same side and issues from the anterior part of the longitudinal fissure, immediately anterior to the optic chiasma; then it crosses the anterior perforated substance, on its way to its termination in the basal vein.

The dissector may find it difficult or even impossible to demonstrate the basal vein and its tributaries if the veins are empty, but in a certain number of specimens they are found without difficulty.

The veins of the supero-lateral surface of the hemisphere are divided into two groups—the superior and the inferior cerebral veins.

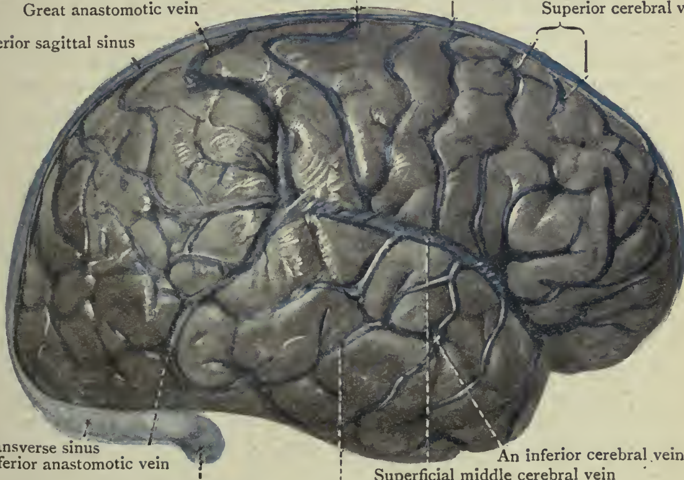


FIG. 143.—Veins of the supero-lateral surface of the Hemisphere. The dura mater has been removed, but the arachnoid and pia mater are *in situ.*

The *superior cerebral veins* run upwards towards the supero-medial border of the hemisphere where they terminate in the superior sagittal sinus. They vary in number from six to twelve. The more anterior veins enter the sinus at right angles, but the orifices of the more posterior veins are directed obliquely forwards—that is, against the blood stream in the sinus (Fig. 143).

The majority of the *inferior cerebral veins* converge towards the posterior ramus of the lateral fissure, where they terminate in the *superficial middle cerebral vein*, which runs forwards, along the fissure, and then, leaving the posterior branch of the fissure, it turns medially, along the stem of the fissure, and ends in the cavernous sinus. If the vein is traced, its terminal cut end will be found in the region of the anterior part of the interpeduncular fossa.

The inferior cerebral veins which do not terminate in the superficial middle cerebral vein run downwards, towards the infero-lateral border of the hemisphere, and they end in the transverse sinus.

In almost all cases there is a direct communication between the superior sagittal sinus and the posterior part of the superficial middle cerebral vein, by means of a vein which is called the *great* or *superior anastomotic vein*; and, very frequently, the posterior part of the superficial middle cerebral vein communicates with the transverse sinus, through one of the inferior cerebral veins which opens into both, and which is called the *inferior* or *small anastomotic vein.* Both the communications may become of importance in cases in which the posterior part of the superior sagittal sinus or the commencements of both transverse sinuses are obstructed.

The majority of the veins on the medial surface of the hemisphere terminate in the anterior cerebral vein, which runs along the upper surface of the corpus callosum, but some end in the inferior sagittal sinus, and some ascend to the superior sagittal sinus.

The veins from the anterior part of the inferior surface of the hemisphere join either the superficial middle cerebral vein or the anterior cerebral vein; those from the posterior part of the inferior surface pass to the basal vein, to the superior petrosal sinus, to the straight sinus, and to the transverse sinus. The veins from the interior of the hemispheres which join the great cerebral vein will be described later (see p. 444).

Veins of the Mid-Brain.—There are no large veins from the mid-brain, and the small veins which return the blood from that part of the brain end either in the great cerebral vein, or in the basal veins, or in both.

Veins of the Cerebellum.—The veins on the superior surface of the cerebellum pass forwards; some terminate in the great cerebral vein, others in the superior petrosal sinuses. Some of the veins of the inferior aspect of the cerebellum end in the straight sinus, others in the transverse sinus, the occipital sinus, or an inferior petrosal sinus.

Veins of the Pons.—The veins from the upper part of the pons join the basal vein, and those from the inferior part either join the cerebellar veins or they end in the inferior petrosal sinuses.

Veins of the Medulla Oblongata.—The smaller veins of the medulla oblongata converge to an anterior and a posterior median vein, or they run along the roots of the last four pairs of cerebral nerves. The anterior median vein communicates, above, with the veins of the pons, and, below, with the veins of the spinal medulla. The posterior median vein also communicates, below, with the veins of the spinal medulla, and it terminates, above, either in the inferior petrosal sinuses or in the basilar plexus. The efferents which accompany the last four cerebral nerves end either in the inferior petrosal sinuses, in the upper parts of the internal jugular veins, or in the pharyngeal plexus.

Arteries which supply Blood to the Brain.—Four main arterial trunks carry blood into the cranium for the supply of the brain—viz., the two internal carotid arteries and the two vertebral arteries. The vertebral arteries enter through the foramen magnum, whilst the internal carotid arteries gain admittance through the lacerate foramina, after traversing the carotid canals. Both the vertebral and the internal carotid arteries were divided when the brain was removed from the cranium. The cut ends of the internal carotids will be seen, at the base of the brain, close to the sides of the optic chiasma. When the remains of the membranes are taken away from around it, each internal carotid will be found to divide, a short distance above its cut extremity and immediately below the anterior perforated substance, into a larger branch, the middle cerebral artery, which runs laterally, and a smaller branch, the anterior cerebral artery, which runs medially.

The vertebral arteries curve round the sides of the medulla oblongata and they unite at its upper border, in the median plane, to form the basilar artery, which runs to the upper border of the pons, where it divides into the two posterior cerebral arteries.

But the cerebral arteries which spring from the internal carotid arteries of opposite sides are brought into association with one another, and with the posterior cerebral arteries, which spring from the basilar, by a remarkable and complete series of anastomoses which take place at the base of the brain, as well as by the anastomoses of their terminal branches in the pia mater on the surfaces of the hemispheres.

The more striking series of anastomoses are those at the base of the brain; they constitute the circulus arteriosus (Willis), and the arteries which take part in the formation of the circle lie in the cisterna interpeduncularis and the cisterna chiasmatis.

Circulus Arteriosus (O.T. **Circle of Willis**).—The series of anastomoses which forms the arterial circle lies at the

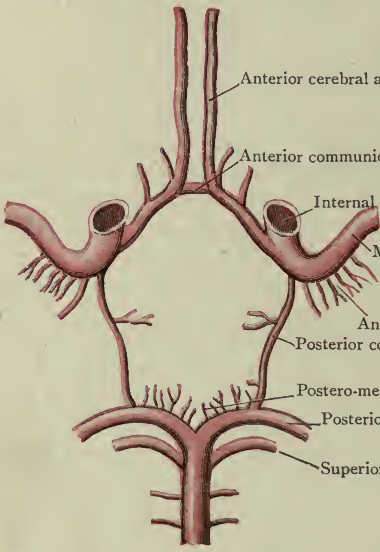


FIG. 144.—Diagram of the Circulus Arteriosus.

base of the brain, in the deep hollow anterior to the pons and around the optic chiasma. The so-called circle has, in reality, a heptagonal or hexagonal outline, and the vessels which compose it lie, as already stated, in the cisterna interpeduncularis and the cisterna chiasmatis. Anteriorly it is formed by the anterior communicating artery, which links together the two anterior cerebral arteries. On each side is the posterior communicating artery, connecting the internal carotid (from which the anterior cerebral springs) with the posterior cerebral. The arterial ring is completed posteriorly by the bifurcation of the basilar artery into the two posterior cerebral vessels (Fig. 144). As a rule, the circulus arteriosus is not symmetrical. One posterior communicating artery is almost invariably larger than its fellow of the opposite side.

Two systems of branches, both going to the cerebrum but differing greatly in their mode of distribution, proceed from the cerebral arteries. One system consists of very numerous,

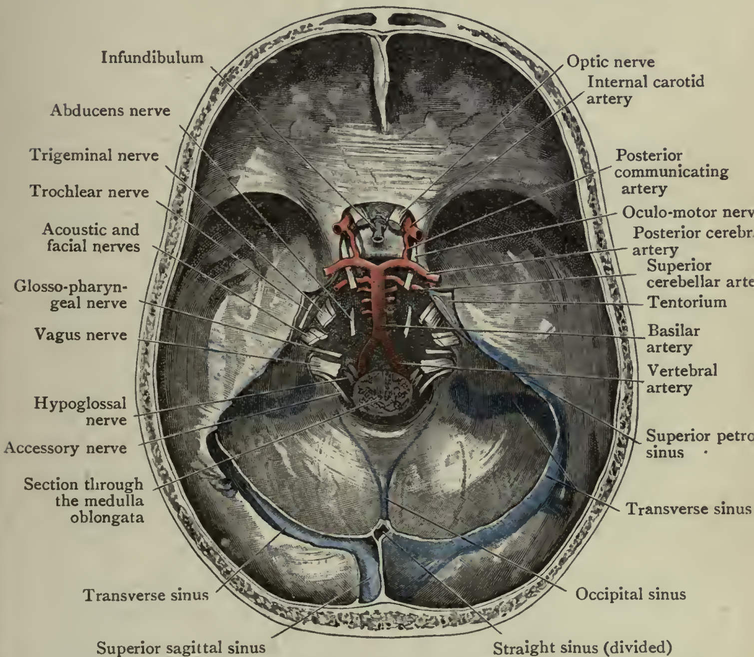


FIG. 145.—Floor of the Cranium after the removal of the Brain and the Tentorium Cerebelli. The blood vessels forming the Circulus Arteriosus have been left in place.

slender twigs, which, as a rule, come off in groups in certain localities, and at once pierce the substance of the cerebrum to gain its interior. It is the system of *central* or *basal branches.* The other system is composed of branches which ramify over the surface of the cerebrum, and it is termed the system of *cortical branches.* The central parts of the brain, including the basal ganglia, receive their blood supply from the central system, and the vessels which constitute that group do not anastomose with each other. The cortical vessels supply the cerebral cortex and the finer branches, which ramify in the pia mater, anastomose with one another; therefore, the neighbouring vascular districts of the cerebral cortex are not sharply cut off from one another.

Arteriæ Vertebrales.—Each vertebral artery enters the subarachnoid space, in the upper part of the vertebral canal, by piercing the dura mater and the arachnoid. Gaining the interior of the cranium, through the foramen magnum, it runs upwards, at first, on the side of the medulla oblongata, but it soon inclines to the anterior aspect of the medulla oblongata, and, meeting its fellow of the opposite side in the median plane, it unites with it, at the lower border of the pons, to form the basilar artery.

The branches given off from the intracranial part of the vertebral artery are:—

1. Posterior spinal.
2. Posterior inferior cerebellar.
3. Anterior spinal.
4. Bulbar.

Arteria Spinalis Posterior.—The posterior spinal artery is the first branch given off from the vertebral artery after it pierces the dura mater. It passes, downwards, on the spinal medulla along the line of the posterior nerve-roots (p. 90).

Arteria Cerebelli Inferior Posterior.—The posterior inferior cerebellar artery is the largest branch of the vertebral artery. It takes origin immediately above the posterior spinal artery, and pursues a tortuous course backwards, on the side of the upper part of the medulla oblongata, between fila of the hypoglossal nerve, and then between fila of the vagus. Finally, turning round the restiform body, it gains the vallecula of the cerebellum and enters the cisterna cerebello-medullaris, where it ends by dividing into two terminal branches. One of the branches ramifies on the posterior part of the inferior surface of the corresponding cerebellar hemisphere, the other runs backwards, in the vallecula, in the groove between the vermis and the hemisphere supplying both. The trunk of the artery gives branches to the medulla oblongata which supply the olive, and the fibres of the spino-cerebellar, the spino-thalamic, the rubro-spinal, and the olivo-cerebellar tracts, as well as the nuclei of the vagus and glosso-pharyngeal nerves (Bury and Stopford).

Arteria Spinalis Anterior.—The anterior spinal artery arises near the lower border of the pons, and it is rare to find the vessels of the two sides of equal size. They converge, on the anterior surface of the medulla oblongata, and unite to form the commencement of the median vessel which extends downwards on the ventral face of the spinal medulla.

The *bulbar arteries* are minute vessels which enter the substance of the medulla oblongata ; they spring both from the vertebral artery itself and also from its branches.

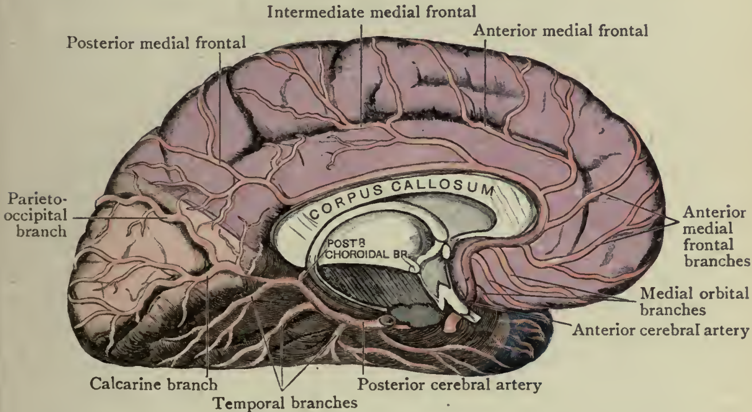


FIG. 146.—Medial and Tentorial Surfaces of the left Cerebral Hemisphere. The district supplied by the anterior cerebral artery is tinted *purple* ; by the middle cerebral artery, *blue* ; and by the posterior cerebral artery, *red*. (Semi-diagrammatic.)

Arteria Basilaris.—The basilar artery runs from the lower border to the upper border of the pons, occupying the median groove of the pons and lying in the median part of the cisterna pontis. It is formed, at the lower border of the pons, by the union of the two vertebral arteries, and it divides, at the upper border, into the two posterior cerebral arteries. It is supported anteriorly by the basilar portion of the occipital bone and the dorsum sellæ of the sphenoid (Fig. 38).

The majority of the branches which spring from the basilar artery arise from its sides and pass laterally from it. They are :—

1. Pontine.
2. Internal auditory.
3. Anterior inferior cerebellar.
4. Superior cerebellar.
5. Posterior cerebral.

Rami ad Pontem.—The pontine branches are numerous slender twigs which run, laterally, on the surface of the pons before they enter its substance.

Arteria Auditiva Interna.—The internal auditory artery will be seen amongst the pontine branches. It accompanies the acoustic nerve into the internal acoustic meatus, and is distributed to the internal ear.

Arteria Cerebelli Inferior Anterior.—The anterior inferior cerebellar artery inclines postero-laterally to reach the anterior part of the inferior surface of the cerebellum.

Arteria Cerebelli Superior.—The superior cerebellar artery, on each side, is a large vessel which springs from the basilar close to its termination. It winds laterally and backwards, round the corresponding pedunculus cerebri, along the upper border of the pons, to the upper surface of the cerebellum, where its terminal branches ramify before entering the grey matter.

Arteria Cerebri Posterior.—Immediately beyond the origin of the two superior cerebellar arteries the basilar artery bifurcates into the two posterior cerebral arteries, which diverge from each other and curve laterally and backwards round the mesencephalon. Then they run backwards towards the inferior surface of the splenium of the corpus callosum. In the first part of its course each posterior cerebral artery lies deeply, in the interval between the corresponding pedunculus cerebri and the hippocampal gyrus; then it enters the calcarine fissure, and ends, in the fissure, by dividing into two terminal branches, viz., the calcarine and the parieto-occipital (Figs. 146, 147).

The oculo-motor nerve passes forwards in the interval between the posterior cerebral and the superior cerebellar arteries, close to the place where they arise from the basilar; and the small trochlear nerve winds round the pedunculus cerebri below the posterior cerebral artery.

The following branches spring from each posterior cerebral artery:—

Central or basal	Postero-median. Postero-lateral. Posterior chorioidal.	Cortical	Temporal. Calcarine. Parieto-occipital.

The *postero-median central arteries* arise close to the origin of the parent trunk. They proceed upwards, in the interval between the pedunculi cerebri, and, after piercing the substantia perforata posterior (O.T. posterior perforated spot), they supply the hypothalamus, the thalamus, and the medial part of the pedunculus cerebri.

The *postero-lateral central arteries* are small slender twigs which arise on the lateral surface of the pedunculus cerebri, and go to the lamina quadrigemina and the thalamus.

The *posterior chorioidal artery* goes to the tela chorioidea of the third ventricle and the chorioid plexus of the lateral ventricle (Figs. 148 and 163).

The cortical branches are distributed to the medial, inferior, and supero-lateral surfaces of the posterior part of the hemisphere (Figs. 146, 147, 148).

The *temporal branches*, two or three in number, turn laterally, over the hippocampal gyrus, and ramify on the inferior surface of the temporal lobe of the cerebrum (Figs. 146 and 147).

The *calcarine branch* follows the calcarine fissure to the occipital pole of the cerebral hemisphere, round which it turns to reach the lateral surface of the occipital lobe. It is the chief artery of supply to the cuneus and the lingual gyrus, and is therefore specially concerned in the nutrition of the visual centres of the cerebral cortex (Fig. 146).

The *parieto-occipital artery* is the smaller of the two terminal branches of the posterior cerebral. It runs upwards in the parieto-occipital fissure, and at the supero-medial margin of the hemisphere it curves laterally to reach the supero-lateral surface of the occipital lobe. It supplies branches to the cuneus and præcuneus (Figs. 146, 148).

Arteria Carotis Interna.—The cut extremity of the internal carotid artery will be found at the lateral side of the optic chiasma, in the angle between the optic nerve and the optic tract. Thence the artery turns laterally, below the substantia perforata anterior, close to the commencement of the lateral fissure, and it ends by dividing into the anterior and middle cerebral arteries (Fig. 144). The *middle cerebral artery* is the larger of the two terminal branches. It appears to be the continuation of the parent trunk and it runs laterally into the stem of the lateral fissure. The *anterior cerebral artery*, on the other hand, passes medially from the internal carotid, almost at a right angle. Consequently emboli pass more frequently into the middle cerebral than into the anterior cerebral artery. From each internal carotid artery, after it has emerged from the cavernous sinus (p. 239), the following branches arise:—

1. Ophthalmic (already studied, p. 252).
2. Posterior communicating.
3. Chorioidal.
4. Middle cerebral.
5. Anterior cerebral.

Arteria Communicans Posterior.—The posterior communicating artery, as a rule, is a slender branch which passes backwards to join the posterior cerebral, between its postero-median and postero-lateral groups of central twigs (Fig. 144).

Arteria Chorioidea.—The chorioidal artery enters the inferior cornu of the lateral ventricle, and passes into the chorioid plexus in that cavity (Fig. 147).

Arteriæ Cerebri Anteriores.—Each anterior cerebral artery runs first horizontally, above the optic chiasma, towards the median plane (Figs. 146, 147). Then, bending sharply upon

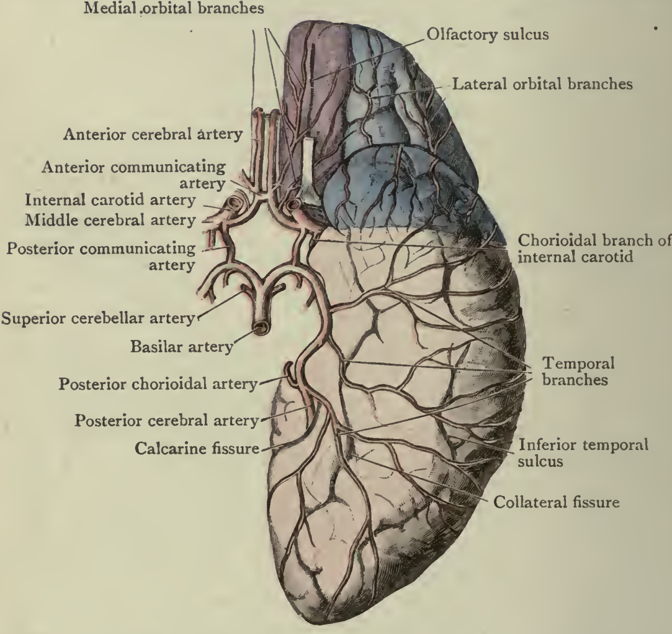


FIG. 147.—Inferior surface of the Cerebral Hemisphere. The districts supplied by the three cerebral arteries are tinted differently: posterior cerebral artery, *red*; middle cerebral artery, *blue*; anterior cerebral artery, *purple.*

itself, it turns upwards, in the anterior part of the longitudinal fissure, anterior to the lamina terminalis, and along the rostrum to the genu of the corpus callosum, round which it bends; then it passes backwards, along the medial face of the corresponding hemisphere, on the upper surface of the corpus callosum, to the parieto-occipital fissure (Fig. 146). As it lies anterior to the lamina terminalis it is connected with the opposite anterior cerebral artery by the *anterior communicating* *artery*, and as it passes along the longitudinal fissure, between the hemispheres, it lies close to its fellow of the opposite side.

Numerous branches proceed from each anterior cerebral artery :—

Basal or central	Antero-medial.
Cortical	Medial orbital. Anterior medial frontal. Intermediate medial frontal. Posterior medial frontal.

The *antero-medial arteries* pierce the base of the brain anterior to the optic chiasma. They supply the rostrum of the corpus callosum, the lamina terminalis, and the septum pellucidum.

The cortical branches supply the greater part of the medial surface of the hemisphere and parts of the orbital and supero-lateral surfaces (Figs. 146, 147, 148).

The *medial orbital branches* are two or three in number. They turn round the margin of the longitudinal fissure to reach the medial part of the orbital surface of the frontal lobe. They supply the gyrus rectus, the olfactory tract and bulb, and the medial orbital gyrus (Figs. 146 and 147).

The *anterior medial frontal artery* ramifies upon the anterior part of the medial surface of the frontal lobe, and its terminal twigs turn round the upper margin of the cerebral hemisphere, and supply the upper part of the supero-lateral surface of the frontal lobe (Fig. 146).

The *intermediate medial frontal artery* ramifies on the medial surface of the frontal lobe posterior to the preceding branch. Its terminal part passes over the paracentral lobule, and reaches the adjacent portion of the supero-lateral surface of the cerebral hemisphere (Figs. 146, 148).

The *posterior medial frontal artery* ramifies on the medial surface of the præcuneus, and its terminal twigs turn round the upper margin of the cerebral hemisphere to gain the supero-lateral surface.

Arteriæ Cerebri Mediæ.—At first each middle cerebral artery passes laterally, along the stem of the lateral fissure, and then upwards in the lateral fossa, where, on the surface of the insula, it breaks up into a number of large terminal branches. Before the posterior ramus of the lateral fissure is opened up to expose the insula in the lateral fossa, the terminal branches may be seen emerging from between its two lips (Fig. 148). Then they diverge and supply a wide area of cortex on the supero-lateral surface of the hemisphere.

The branches which spring from each middle cerebral artery may be classified as follows :—

Central or basal branches.	Antero-lateral.	
Cortical branches.	Frontal	Lateral orbital. Inferior lateral frontal. Ascending frontal.
	Parietal	Ascending parietal.
	Parieto-temporal.	
	Temporal.	

The arteries of the *antero-lateral central group* are very numerous. They pierce the substantia perforata anterior and supply the lentiform nucleus, the internal capsule and the external capsule, the caudate nucleus, and a portion of the thalamus.

The cortical branches supply the greater part of the supero-lateral surface of the hemisphere, the lateral half of the orbital surface, the lower surface of the interior part of the temporal lobe and the temporal pole (Figs. 147, 148).

The *frontal* and *parietal branches* turn round the upper lip of the posterior ramus of the lateral fissure and ascend on the supero-lateral surface of the hemisphere. The *frontal branches* are: (1) *lateral orbital*,

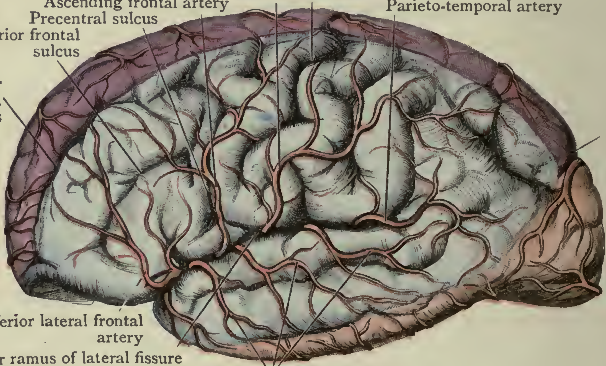


FIG. 148.—Supero-lateral surface of the Cerebral Hemisphere. The districts supplied by the three cerebral arteries are tinted differently: anterior cerebral, *purple*; middle cerebral, *blue*; posterior cerebral, *red*. (Semi-diagrammatic.)

to the lateral part of the orbital surface of the frontal lobe; (2) *inferior lateral frontal*, to the inferior and middle frontal gyri; (3) *ascending frontal*, which runs upwards in relation to the anterior central gyrus (Figs. 147, 148).

The *ascending parietal branch* extends, in an upward and backward direction, in relation to the posterior central gyrus, and its terminal twigs supply the greater part of the cortex of the superior parietal lobule (Fig. 187).

The *parieto-temporal branch* is a very large artery which issues from the posterior part of the posterior ramus of the lateral fissure; it sends branches upwards to the inferior parietal lobule, and others which incline downwards over the posterior part of the temporal lobe. Its twigs, as a rule, do not encroach upon the supero-lateral surface of the occipital lobe (Fig. 148).

The *temporal branches*, two or three in number, issue from the posterior ramus of the lateral fissure, and, turning downwards and backwards, over its lower lip (*i.e.* the superior temporal gyrus), they ramify upon the lateral surface of the temporal lobe (Fig. 148).

The dissector should note that the branches of the middle cerebral artery supply the greater part of the motor area of the cortex, the greater part of the area for ordinary sensation, and area for hearing (cp. Figs. 148 and 153).

Dissection.—When the distribution of the branches of the cerebral arteries has been noted, the dissectors must remove the blood vessels and the remains of the arachnoid first from the base of the brain and then from the supero-lateral surfaces of the hemispheres, commencing with the base. The dissection must be done with forceps and a pair of scissors. In the basal region very delicate manipulation is necessary, because the cerebral nerves, at their points of attachment to the brain, are so intimately connected with the pia mater that any undue traction applied to the membranes will tear the nerves away. Indeed, in the case of the medulla oblongata, the dissector is advised to leave the pia mater in position until the nerve-roots have been studied. The relation of the pia mater to the fourth ventricle also renders this desirable.

The removal of the arachnoid and pia mater from the supero-lateral surface must be commenced at the margins of that surface, and the membranes must be reflected towards the lateral fissure. When the margins of the fissure are reached they must be pulled apart, then the larger branches and the associated parts of the membranes, which lie in the fissure, can be seen, but they must not be removed at present. Cut through the membranes and the vessels along the margins of the fissure, but leave their deeper parts *in situ*. Of course, at the present stage, the membranes cannot be removed from every part of the brain; but as the dissection proceeds, opportunities for completing the process will arise.

After the vessels and the membranes are removed from the base and from the supero-lateral surfaces of the hemispheres, the dissectors should commence their more detailed study of the brain by the investigation of the base.

THE BASE OF THE BRAIN.

When the membranes and the blood vessels are removed from the base of the brain two large rope-like strands, called the *pedunculi cerebri* (O.T. crura), will be seen issuing from the upper part of the pons. As the peduncles emerge from the pons they are close together, but they diverge as they pass upwards and forwards, and, finally, each peduncle disappears into the base of the corresponding cerebral hemisphere. As each peduncle passes into the corresponding hemisphere it is embraced, on its lateral side, by the hippocampal gyrus, but between the gyrus and the peduncle is a white, flattened band, called *the optic tract*, which is closely applied to the side of the peduncle. The two optic tracts converge as they pass forwards, and, finally, they are joined together by a short, transverse commissural portion termed *the optic chiasma.* The optic chiasma lies at the anterior end of the *interpeduncular fossa*, and below the posterior end of that portion of the longitudinal fissure which intervenes between the inferior surfaces of the frontal lobes of the brain. The optic nerves enter the antero-lateral angles of the chiasma.

Fossa Interpeduncularis.—The interpeduncular fossa is the rhomboidal region which is bounded posteriorly by the pons, postero-laterally by the cerebral peduncles, antero-laterally by the optic tracts, and anteriorly by the optic chiasma; within the limits of the fossa the following parts are situated—(1) the oculo-motor nerves; (2) the substantia perforata posterior; (3) the corpora mamillaria; and (4) the tuber cinereum, with the infundibulum.

Nervus Oculomotorius.—Each oculo-motor nerve issues from the medial side of the corresponding cerebral peduncle, below the posterior perforated substance (Fig. 149).

Substantia Perforata Posterior (O.T. **Posterior Perforated Space**).—The posterior perforated substance forms the roof or superior wall of the posterior and deepest part of the interpeduncular fossa. It is a layer of grey matter in which there are numerous small apertures. The apertures are caused by the postero-medial central branches of the posterior cerebral arteries, which were withdrawn from the apertures when the pia mater was removed.

Corpora Mamillaria.—The mamillary bodies are two small, white, pea-shaped eminences, placed side by side immediately anterior to the posterior perforated substance. They form part of the hypothalamic region, and, at a later stage of the dissection, their connections with the columns of the fornix will be displayed.

Tuber Cinereum.—The tuber cinereum is a slightly raised field of grey matter which occupies the interval between the optic chiasma, anteriorly, the corpora mamillaria, posteriorly, and the optic tracts laterally. Springing from the anterior part of the tuber cinereum, immediately posterior to the optic chiasma, is the infundibulum or stalk of the hypophysis. When the brain was removed the connection of the infundibulum with the hypophysis was severed (p. 106).

Substantiæ Perforatæ Anteriores.—The anterior perforated areas are small triangular districts of grey matter, one on each side. Each is bounded, posteriorly, by the uncinate extremity of the hippocampal gyrus; anteriorly, by the diverging striæ of the olfactory tract; and, medially, by the optic tract. Laterally, it passes into the roof of the lateral fissure, and is perforated by the antero-lateral central arteries (Figs. 147, 149). The grey matter of each anterior perforated area is continuous, above, with a mass of grey matter in the base of the corresponding cerebral hemisphere which is called the corpus striatum (Fig. 185).

Lamina Terminalis.—The lamina terminalis, which was originally the anterior wall of the brain, will be displayed if the optic chiasma is pulled gently backwards. It is a thin lamina which passes upwards from the chiasma into the longitudinal fissure, to become connected with the rostrum of the corpus callosum. It closes the third ventricle anteriorly, and is continuous, on each side, with the grey matter of the substantia perforata anterior (Fig. 186).

Superficial Attachments of the Cerebral Nerves.—Twelve cerebral nerves arise from or enter the brain, on each side of the median plane. They are the olfactory or first, consisting of about twenty separate filaments; the optic or second; the oculo-motor or third; the trochlear or fourth; the trigeminal or fifth; the abducent or sixth; the facial or seventh; the acoustic or eighth; the glosso-pharyngeal or ninth; the vagus or tenth; the accessory or eleventh; and the hypoglossal or twelfth.

A thirteenth pair of cerebral nerves, called the *nervi terminales*, is known. Each nervus terminalis is attached to the cerebrum posterior to the olfactory striæ. Its fibres run alongside the corresponding olfactory tract, and are distributed with the olfactory nerves to the upper parts of the wall of the nasal cavity. The functions of the nervi terminales are unknown.

Each nerve is said to have a "superficial attachment" and a "deep" origin or termination. By the term "superficial attachment" is meant the region where its fibres enter or leave the brain surface; the terms "deep termination and origin" indicate the connections which are established by the fibres of the different nerves with nuclei or clusters of nerve-cells within the substance of the brain. The nuclei are of two kinds: (1) those in connection with which the afferent or entering nerve fibres end; and (2) those from which the efferent or emerging nerve fibres arise. It is the superficial attachments only which come under notice of the dissector at the present time.

No fewer than eight pairs of the cerebral nerves, from the fifth to the twelfth inclusive, have a superficial attachment to

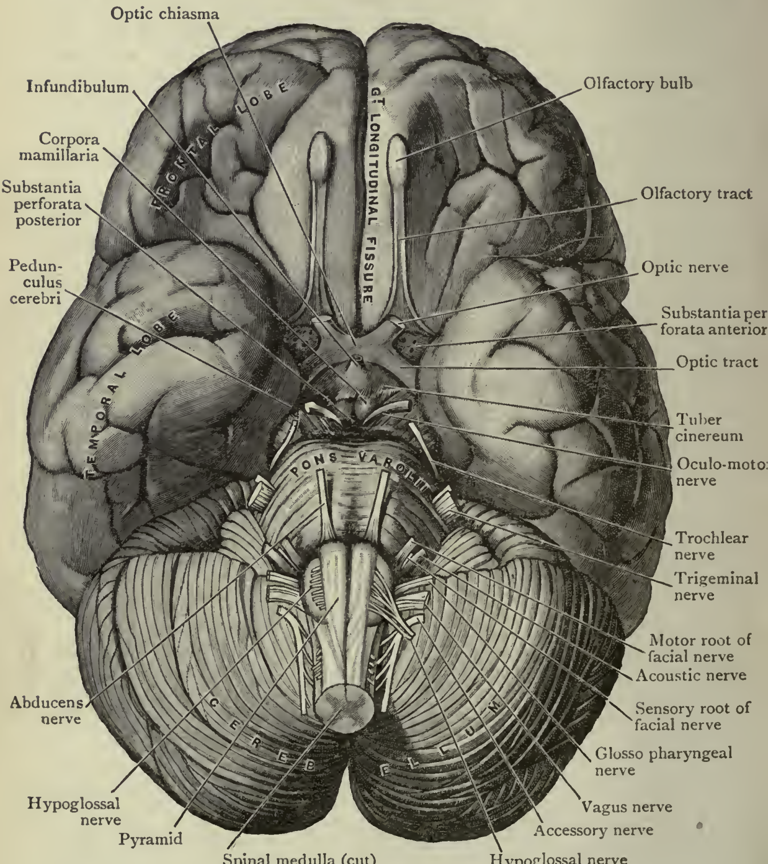


FIG. 149.—The Base of the Brain with the Cerebral Nerves attached.

the medulla oblongata and the pons—that is to the ventral part of the hind brain.

Nervus Hypoglossus.—Upon the lateral aspect of the upper half of the medulla oblongata there is a very conspicuous oval prominence called the olive. Medial to the olive is a large elongated strand of the medulla oblongata, termed the pyramid; it is separated from the olive by a groove or sulcus which is prolonged downwards for some distance beyond the olive. From the part of the sulcus between the olive and the pyramid spring the fila of the *hypoglossal nerve* (Figs. 149, 150); and from the lower part of the sulcus some of the fila of the *anterior root of the first cervical nerve* issue.

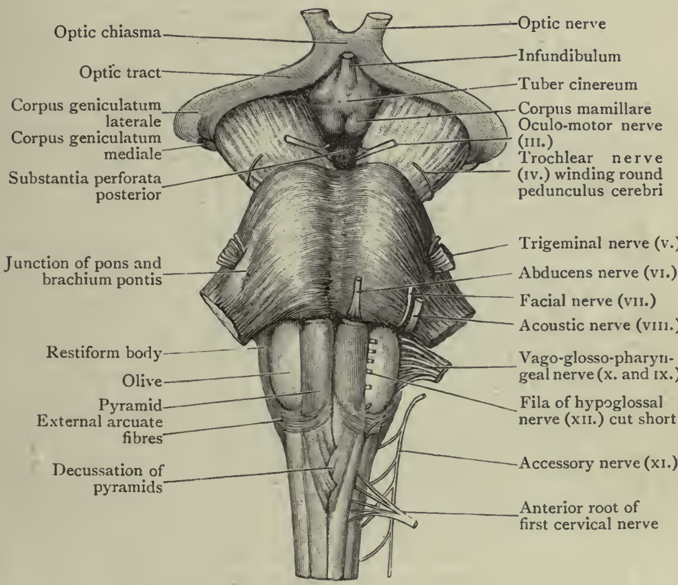


FIG. 150.—Anterior aspect of the Medulla Oblongata, Pons, and Mesencephalon of a full-time Fœtus.

Nervi Glossopharyngeus et Vagus et Accessorius.—Posterior to the olive is the post-olivary sulcus, and a little more dorsally lies the postero-lateral sulcus of the medulla oblongata, in which a continuous row of nerve fila is attached. The fila in question extend downwards, beyond the level of the olive, and are attached to the whole length of the medulla oblongata in linear order. They belong to three nerves, but it is impossible at present (seeing that the nerve-trunks which they build up are divided) to determine precisely the number of fila which belong to each. From below upwards, the nerves which they form are the *accessory*, the *vagus*, and the *glosso-pharyngeal*. The fila of the vagus and the glosso-pharyngeal are much more closely crowded together than those of the accessory (Fig. 150).

The roots of the accessory which spring from the medulla oblongata constitute only one part of the nerve. The *spinal part* springs from the spinal medulla, as low down as the sixth

FIG. 151.—Section through the Head a little to the right of the Median Plane. It shows the posterior cranial fossa and the upper part of the vertebral canal after the removal of brain and the spinal medulla.

cervical nerve, by a series of roots which issue from the lateral funiculus, posterior to the attachment of the ligamentum denticulatum (p. 83) (Figs. 149, 151).

Nervus Acusticus et Nervus Facialis.—The acoustic and facial nerves are attached, close together, at the lower border of the pons, and immediately above the restiform body, which extends from the medulla oblongata to the cerebellum (p. 479) (Figs. 150, 151). The *acoustic nerve* is the larger of the two, and it lies on the lateral side of the facial. Its two roots embrace the restiform body; the dorsal of the two is the cochlear root, the ventral is the vestibular root.

The *facial nerve* is attached at the lower border of the pons, just to the medial side of the acoustic nerve, by two roots —a large motor root, and a small sensory root (O.T. pars intermedia) (Figs. 150, 151). The two roots unite in the internal acoustic meatus.

Nervus Abducens.—The abducens is a small nerve which emerges from the groove between the lower border of the pons and the lateral part of the pyramid. It is flattened out near its origin and a surface view of it in that region gives a deceptive idea of its size (Figs. 149, 150).

Nervus Trigeminus.—The trigeminal is the largest of all the cerebral nerves. It is attached to the side of the pons, nearer its upper than its lower border, by two roots—a large sensory root and a small motor root, which are in a line with the facial and acoustic nerves. The large, sensory root (*portio major*) is composed of a great number of fila loosely held together, but the small, motor root (*portio minor*) is more compact, and it emerges antero-medial to the point at which the sensory root enters the pons (Figs. 149, 151).

Nervus Trochlearis.—The superficial origin of the trochlear or fourth nerve can be seen when the anterior part of the superior vermis of the cerebellum is displaced backwards. It emerges from the anterior medullary velum, on the dorsal aspect of the brain-stem, immediately below the quadrigeminal lamina. It is a slender nerve and it has a long intracranial course. In the first part of its course it winds round the lateral side of the pedunculus cerebri, between the cerebrum and cerebellum, to reach the interpeduncular region (Figs. 149, 150).

Nervus Oculomotorius.—The oculo-motor nerve issues, by several fila, from the sulcus oculomotorius on the medial face of the cerebral peduncle in the interpeduncular fossa (Figs. 149, 150).

Nervus Opticus.—The optic nerve is a large round nerve which joins the antero-lateral angle of the optic chiasma (Fig. 149).

Nervi Olfactorii.—The olfactory nerves, about twenty in number on each side, arise in the nasal mucous membrane. They pass into the cranium through the cribriform lamina of the ethmoid, and they terminate in the olfactory bulb. It is not probable that the dissector will find any trace of them on the brain.

THE CEREBRUM.

The term cerebrum includes (1) the two cerebral hemispheres which, together, form the telencephalon and (2) the boundaries of the third ventricle which, collectively, form the diencephalon. The two parts, that is the telencephalon and the diencephalon, are intimately connected with one another.

Each hemisphere is separated from its fellow of the opposite side by a deep fissure called the longitudinal fissure. Anteriorly and posteriorly the longitudinal fissure completely separates the two hemispheres, but in the intermediate region the hemispheres are connected with one another, across the bottom of the longitudinal fissure by a large transverse commissure called the corpus callosum, which can be seen when the hemispheres are drawn apart.

Cerebral Hemispheres.—It has been pointed out already that each cerebral hemisphere possesses three surfaces, three poles and five borders. The surfaces are supero-lateral, medial and inferior. The poles are frontal, occipital and temporal. The borders are supero-medial, infero-lateral, superciliary, medial orbital and medial occipital.

The *frontal pole* is the most projecting part of the anterior extremity of the hemisphere. It is blunt and rounded, and it lies behind the medial part of the superciliary eminence of the frontal bone. The *occipital pole* is the posterior extremity of the hemisphere. It is more pointed than the frontal pole. It lies immediately above and lateral to the external occipital protuberance (inion). In a well-hardened brain the occipital pole of the right hemisphere is usually marked, on its medial aspect, by a broad groove caused by the posterior end of the superior sagittal sinus.

The *supero-lateral surface* is convex and is adapted to the concavity of the cranial vault. The *medial surface* is flat and, when the brain is *in situ*, it is more or less completely separated from the corresponding surface of the opposite hemisphere by the falx cerebri and the prolongations of the arachnoid and the pia mater which occupy the longitudinal fissure between the two hemispheres. The *inferior surface* is irregular and is adapted to the floors of the anterior and middle cranial fossæ, and to the upper surface of the tentorium cerebelli. It is separated into anterior and posterior parts by a deep transverse fissure called the stem of the lateral fissure. The anterior or orbital part lies on the floor of the anterior fossa, that is on the roof of the orbit. It is concave, and it looks downwards and laterally; consequently it is partially visible when the hemisphere is viewed from the lateral side (see Figs. 152, 155). The posterior part is concavo-convex. It looks downwards and medially. Its anterior extremity forms the rounded temporal pole, which abuts against the posterior part of the lateral wall of the orbit. Behind the temporal pole its anterior convex part lies on the anterior part of the floor of the middle cranial fossa which separates it from the infra-temporal fossa. The anterior part of its concave portion rests upon the anterior surface of the petrous part of the temporal bone which separates it from the tympanic cavity, the internal ear and the carotid canal. It is separated from the anterior surface of the apex of the petrous part of the temporal bone by the semilunar ganglion of the trigeminal nerve, and it is marked near its lateral margin by a depression caused by the eminentia arcuata of the temporal bone.

The posterior and longer part of the concave area rests upon the tentorium cerebelli which intervenes between it and the cerebellum.

The *supero-medial border* extends from the frontal to the occipital pole; it is convex and is in relation with the wall of the superior sagittal sinus.

The *infero-lateral border* is concave in the posterior part of its extent, where it rests upon the tentorium cerebelli and is in relation with the wall of the transverse sinus; and the anterior part, which lies along the line of union of the squamous with the petrous part of the temporal bone, is convex.

The *superciliary border* extends from the frontal to the temporal pole. It lies parallel with and above the supra-orbital margin. It separates the supero-lateral surface from the orbital part of the inferior surface.

The *medial orbital margin* can be seen at the base of the brain; it extends from the frontal pole to the optic chiasma, along the side of the inferior part of the anterior portion of the longitudinal fissure. It lies above the roof of the nose.

It separates the orbital part of the inferior surface from the medial surface.

The *medial occipital border* can be seen from below, after the hind-brain and the mid-brain have been cut away from the cerebrum, or from behind, when the posterior parts of the hemispheres are separated from one another. It extends from the occipital pole to the posterior end of the corpus callosum. It lies along the margin of the inferior part of the posterior portion of the longitudinal fissure, in relation with the wall of the straight sinus; and it separates the medial surface from the posterior part of the inferior surface.

Fissura Longitudinalis.—The longitudinal fissure is the great median cleft between the two cerebral hemispheres; anteriorly and posteriorly, it completely separates the hemispheres from each other, but the intermediate part is bounded below by the corpus callosum which passes between the hemispheres and connects them together. If the two sides of the longitudinal fissure are gently drawn asunder, the upper surface of the corpus callosum will be displayed. When the brain is *in situ* the longitudinal fissure contains the falx cerebri of the dura mater (p. 104), a fold of arachnoid, the pia mater covering the medial surfaces of the hemispheres, the anterior cerebral arteries and veins, with their branches and tributaries. The falx cerebri was removed when the brain was taken from the skull; the other membranes and the vessels are still *in situ*, and they should not be disturbed till the medial surfaces of the hemispheres can be examined (p. 419).

Dissection.—Separate the cerebellum, pons and medulla from the cerebrum, if that has not already been done, by cutting transversely through the upper part of the mid-brain. Then, if two brains are available, split one of them in the median plane by placing a long knife in the longitudinal fissure and dividing carefully the various parts which connect the two halves together. All three surfaces of each hemisphere will then be exposed, the gyri and sulci can be studied fully and satisfactorily, and the terminal parts of the anterior and posterior cerebral arteries (pp. 384, 386) can be examined. If only one brain is at the disposal of the dissectors they should not, at this stage, separate the cerebral hemispheres from each other, but should endeavour to follow out the gyri and sulci with the various parts of the brain in position. No doubt they will study the hemispheres in that way at some disadvantage, but as the dissection proceeds, opportunities will occur which will enable them to examine those districts of the surface which they can see only imperfectly at present.

Cerebral Gyri and Sulci.—The surface pattern which is presented by the cerebral gyri and sulci is, in its general features, the same in all human brains; but when the comparison is pushed into more detail many differences become manifest, not only in the brains of different subjects but also in the two cerebral hemispheres of one subject.

The depressions which intervene between the cerebral gyri vary in depth. Some are due to folding of the whole thickness of the wall of the cerebrum, and consequently they correspond with elevations of the walls of the cavities of the cerebrum which are called the lateral ventricles. Such depressions are called *complete fissures*. In this category are included—(1) the anterior portion of the calcarine fissure; (2) a portion of the collateral fissure; and (3) the chorioidal fissure. The *incomplete fissures and the sulci* are merely furrows of varying depth which do not produce any effect on the surface of the ventricular walls.

General Structure of the Cerebral Hemispheres.—Each cerebral hemisphere is composed of an outside coating of grey matter, spread in a continuous and uninterrupted layer over its surface, and an internal core of white matter. The grey coating is termed the *cerebral cortex*, whilst the white internal part is called the *medullary centre*. Each gyrus shows a corresponding structure. It has an external covering of grey matter supported upon a core of white medullary matter. But, in addition to the grey matter on the outside, there are certain large deposits of grey matter embedded in the substance of each hemisphere in its basal part. Those deposits constitute the basal ganglia, and although to a certain extent they are isolated from the grey matter on the surface, nevertheless, at certain points, they are directly continuous with it (Fig. 186).

By means of the gyri and sulci the grey matter on the surface of the hemisphere is increased, and its close association with the vascular pia mater is maintained without any unnecessary increase of the bulk of the organ. The vascular pia mater dips into every fissure and sulcus, and opportunity is, therefore, afforded for the cortical vessels to break up into twigs of exceeding fineness before they enter the substance of the hemisphere. The distribution of the blood to the grey cortex is in that way rendered uniform.

Cerebral Lobes and Interlobar Fissures and Sulci.—For purposes of localisation and description, it is customary to divide the hemispheres into districts termed *lobes*, and, for that purpose, certain fissures and sulci are chosen which are termed *interlobar fissures and sulci*: they are the following:—

1. The lateral fissure (O.T. Sylvian).
2. The central sulcus (O.T. fissure of Rolando).
3. The parieto-occipital sulcus.
4. The collateral fissure.
5. The circular sulcus (O.T. limiting sulcus of Reil).

FIG. 152—Supero-lateral aspect of Left Hemisphere (semi-diagrammatic). The orbital surface is shaded.

The lobes which are mapped out by the fissures mentioned are—(1) the frontal; (2) the parietal; (3) the occipital; (4) the temporal; (5) the insula. To them may be added a sixth lobe, in no way related to the interlobar fissures, viz., the olfactory lobe.

Fissura Lateralis (O.T. **Sylvian**).—The lateral fissure is the most conspicuous fissure on the surface of each cerebral hemisphere. It is composed of a short main stem, from the lateral extremity of which three branches radiate. The *stem* is placed on the inferior surface of the cerebrum (Fig. 138).

It begins at the substantia perforata anterior. Thence it passes laterally, forming a deep cleft between the temporal pole and the orbital area of the inferior surface of the hemisphere. When it reaches the lateral surface of the hemisphere, the fissure immediately divides into three radiating branches—(1) the ramus posterior; (2) the ramus anterior horizontalis; and (3) the ramus anterior ascendens.

The *posterior branch* (Figs. 138, 152) is the longest and the most important of the three. It extends backwards, with a slight upward inclination, for a distance of 7.5 cm. (*three inches*) or more, between the temporal lobe, which is placed below it, and the frontal and parietal lobes, which lie above it. Finally, it turns upwards, into the parietal lobe, in the form of an *ascending terminal piece* (Figs. 138, 152).

The *anterior horizontal branch* (Fig. 152) runs forwards in the frontal lobe, for a distance of about 19 mm. (*three-quarters of an inch*), immediately above and parallel to the posterior part of the superciliary margin of the hemisphere.

The *anterior ascending branch* (Figs. 138, 152) passes upwards, with a slight anterior inclination, into the lower part of the lateral surface of the frontal lobe for a distance of about 25 mm. (*one inch*). In many cases the two anterior limbs spring from a common stem of variable length.

Sulcus Circularis (O.T. **Limiting Sulcus of Reil**).—If the lips of the posterior ramus of the lateral fissure are gently pulled asunder, the *insula* (O.T. island of Reil) will be seen at the bottom of the cleft which is termed the lateral fossa (Fig. 157). It is surrounded by a sulcus, called the circular sulcus, which is separable into three parts, viz., an *upper part*, bounding the insula above, a *lower part*, marking it off below, and an *anterior part* limiting it anteriorly. The insula thus mapped out is somewhat triangular in outline, and over its surface ramify branches of the middle cerebral artery.

Opercula Insulæ.—The present is a good time to study the manner in which the insula is shut off from the surface of the hemisphere. When the lateral fissure is held widely open, it will be noted that the insula is overlaid by portions of cerebral cortex which appear as if they were undermined. The overlying portions are called the *opercula insula*, and it is their opposed margins which form the boundaries of the lateral fissure. The opercula are four in number, and are named—(1) temporal, (2) fronto-parietal, (3) frontal, and (4) orbital. They are easily distinguished.

The *temporal operculum* extends upwards over the insula from the temporal lobe; it forms the lower lip of the posterior ramus of the lateral fissure (Fig. 152).

The *fronto-parietal operculum* is carried downwards over the insula to meet the temporal operculum. Its margin forms the upper lip of the posterior ramus of the lateral fissure.

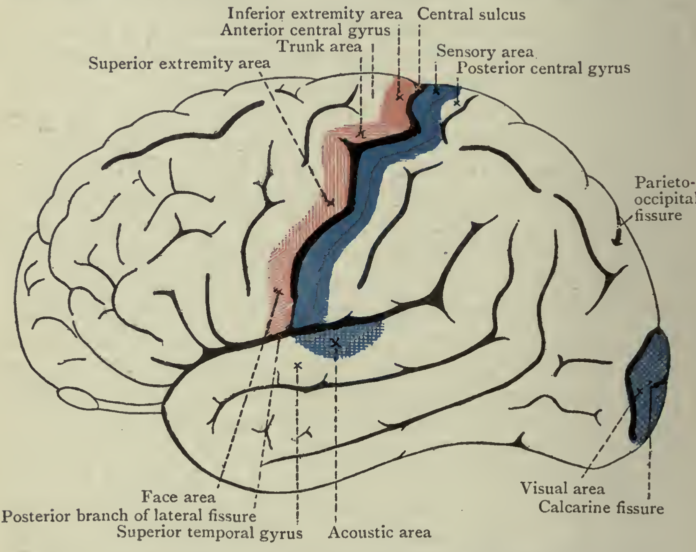


FIG. 153.—Lateral aspect of Left Hemisphere, showing Motor and Sensory Areas. (After Elliot Smith.)

The *frontal operculum* is the small triangular piece of cerebral cortex between the anterior ascending and horizontal branches of the lateral fissure. It is sometimes termed the *pars triangularis.*

The *orbital operculum* is for the most part on the under surface of the hemisphere. It lies below the anterior horizontal limb of the lateral fissure, and passes backwards from the orbital aspect of the frontal lobe over the anterior part of the insula.

Sulcus Centralis (O.T. **Fissure of Rolando**).—The central sulcus runs obliquely across the supero-lateral surface of the hemisphere, somewhat nearer the posterior than the anterior end. It lies between two gyri which, though they are obliquely placed, are still the most vertical gyri on the supero-lateral surface, and it separates the frontal from the parietal lobe. The upper end of the sulcus frequently cuts the supero-medial border of the hemisphere, and, in such cases, it appears on the medial surface of the hemisphere. The lower end, as a rule, is separated from the posterior ramus of the lateral fissure by a small bounding gyrus. The sulcus does not take a straight course between its two extremities; on the contrary, it is bent upon itself several times, on account of buttress-like projections from its bounding walls (Figs. 138, 153). The two most prominent buttresses spring from the anterior wall, which is formed by the anterior central gyrus. From its upper end the sulcus runs, at first, downwards and forwards to the base of the upper buttress; then it bends, first round the upper and next round the lower buttress; finally, its lowest part runs almost vertically downwards from the base of the lower buttress. The anterior central gyrus, which forms the anterior boundary of the central sulcus, constitutes the motor region of the cerebral cortex, and by means of the buttresses which spring from its posterior face it is possible to define in a fairly accurate manner the various motor areas. The lower limb area extends from the upper end of the central sulcus to the apex of the upper buttress; the trunk area corresponds with the lower face of the upper buttress; the upper limb area corresponds with the region of the lower buttress; and the head area corresponds with the anterior boundary of the central sulcus below the lower buttress.

When the margins of the central sulcus are gently separated, a transverse annectant gyrus will be found crossing its floor and uniting together the anterior and posterior central gyri. It lies at the level of the lower part of the upper buttress of the anterior central gyrus.

Fissura Parieto-occipitalis.—The greater part of the parieto-occipital sulcus is situated on the medial surface of the cerebral hemisphere (Fig. 159); only the small lateral part appears on the supero-lateral face (Fig. 153).

The *lateral part of the parieto-occipital fissure* (O.T. *external parieto-occipital*) cuts the supero-medial border of the hemisphere, in a transverse direction, from 37.5 to 50 mm. (*one* *and a half to two inches*) anterior to the occipital pole. It is about 12.5 mm. (*half an inch*) in length, and it is brought to an abrupt termination laterally by an arching gyrus, called the *arcus parieto-occipitalis*, which winds round it (Fig. 154).

The *medial part of the parieto-occipital fissure* (Fig. 159) will be seen when the medial surface of the hemisphere is studied (p. 419).

The Lobes seen on the Supero-lateral Surface of the

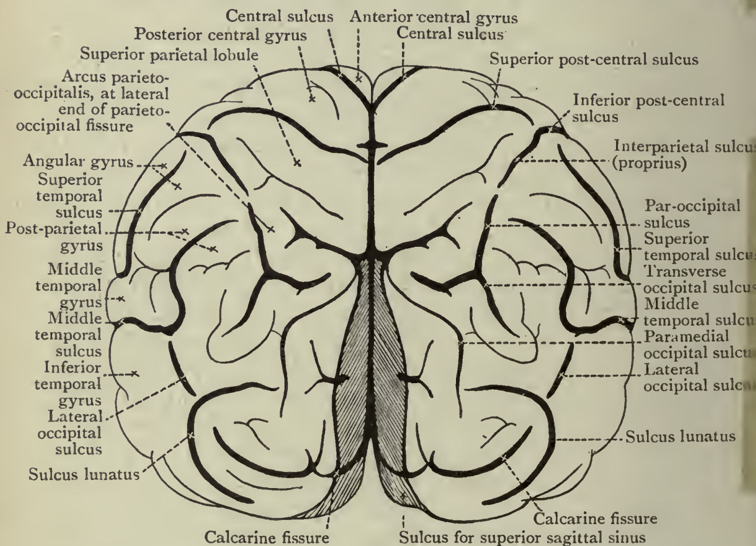


FIG. 154.—Posterior view of the Hemispheres of the Brain (semi-diagrammatic). The posterior parts of the supero-medial borders are separated and portions of the medial surfaces are seen (shaded).

Hemisphere, and the Insula.—The dissector must understand that the areas called the *lobes* of the cerebrum are defined merely for purposes of description and localisation; they do not correspond with physiological areas, nor do they correspond, exactly, in extent with the bones after which they are named. For example, the lobes which can be seen on the supero-lateral surface, without any disturbance of its parts, are the frontal, the parietal, the occipital and the temporal. It is true that all those lobes lie in relation with the bones after which they are named, but only the parietal

PLATE IV

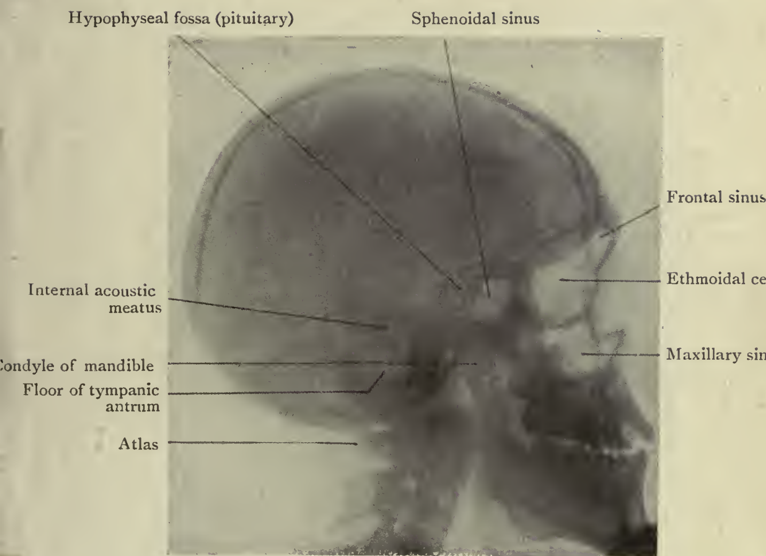


FIG. 41.—Lateral radiograph of a living Skull. (Gouldesbrough.)

PLATE V

FIG. 42. —Lateral view of Skull showing hypophyseal fossa and sphenoidal sinus. (Gouldesbrough.)

lobe is entirely under cover of the parietal bone; whilst, on the other hand, the parietal bone covers all the parietal lobe and parts of each of the other lobes—a considerable part of the frontal lobe, and smaller portions of the occipital and temporal lobes. Further, each of the lobes forms part not only of the supero-lateral but also, at least, of one other surface of the hemisphere, where it lies in relation with parts other than the bones after which it is named (Fig. 177).

Lobus Frontalis.—The frontal lobe appears on the supero-lateral, the inferior, and the medial surfaces of the hemisphere.

The *Supero-lateral Surface of the Frontal Lobe* is bounded, above, by the supero-medial border; below, by the superciliary border and the anterior part of the posterior ramus of the lateral fissure; and it extends, antero-posteriorly, from the frontal pole to the central sulcus. It is divided by three sulci into four chief gyri. The sulci are the precentral, and the superior and inferior frontal. The gyri are the anterior central and the superior, middle and inferior frontal.

Sulcus Præcentralis.—The precentral sulcus consists of two parts, superior and inferior: they run obliquely upwards and backwards, parallel with the central sulcus of the hemisphere, and although they are sometimes continuous in the adult they are developed independently of one another. The superior precentral sulcus is generally connected with the superior frontal sulcus. The inferior precentral sulcus has usually two limbs, a vertical, which lies parallel to the lower part of the central sulcus, and a horizontal or oblique limb which extends forwards into the middle frontal gyrus (Figs. 138, 152).

Sulcus Frontalis Superior (Figs. 138, 152).—The superior frontal sulcus extends forwards from the superior precentral sulcus.

Sulcus Frontalis Inferior (Figs. 138, 152).—The inferior frontal sulcus commences posteriorly in the angle between the vertical and the horizontal or oblique part of the inferior precentral sulcus, and, not uncommonly, it is confluent with one or other of the two parts. As it passes forwards it descends towards the superciliary border and ends a short distance from it in a terminal bifurcation.

Gyrus Centralis Anterior.—The anterior central gyrus extends, obliquely, across the supero-lateral surface of the hemisphere, from the supero-medial border above, to the posterior ramus of the lateral fissure, below. It lies between the central and the precentral sulci and is the region of the motor area of the brain. It is continuous, at its upper and its lower ends, round the extremities of the central sulcus, with the posterior central gyrus. From its posterior face two buttresses, an upper and a lower, project backwards, as pointed out on p. 403. The buttresses form excellent landmarks for the delimitation of the parts of the motor area. Anteriorly, the anterior central gyrus is continuous with the superior, middle, and inferior frontal gyri, and, inferiorly, it forms part of the fronto-parietal operculum (p. 401). Its lower two-thirds are supplied by the middle cerebral artery, and its upper third is supplied by the anterior cerebral artery (Fig. 148).

Gyrus Frontalis Superior.—The superior frontal gyrus lies above the superior frontal sulcus. It forms also part of the supero-medial border and part of the medial surface of the hemisphere. It is continuous, posteriorly, with the anterior central gyrus, and, anteriorly, round the frontal pole, with the gyrus rectus and the medial orbital gyrus of the inferior surface of the frontal lobe. The supero-lateral part of the superior frontal gyrus is frequently divided into upper and lower parts by an interrupted furrow called the *paramedial frontal sulcus* (Fig. 137).

Gyrus Frontalis Medius.—The middle frontal gyrus lies between the superior and inferior frontal sulci. It is continuous, posteriorly, with the anterior central gyrus, and, round the superciliary border, with the anterior orbital gyrus of the inferior surface of the frontal lobe. The horizontal or oblique limb of the inferior precentral sulcus cuts into its posterior end (Fig. 138).

Gyrus Frontalis Inferior.—The centre for speech has been associated with the posterior part of the inferior frontal gyrus of the left side; therefore the inferior frontal gyrus is a region of special interest. It extends forwards, from the inferior precentral sulcus, and is continuous, round the superciliary border, with the lateral and posterior orbital gyri of the inferior surface of the frontal lobe. The inferior frontal gyrus is divided into three parts by the anterior ascending and the anterior horizontal rami of the lateral fissure. The posterior part is sometimes called the *pars basilaris*; it lies between the anterior ascending ramus of the lateral fissure and the inferior precentral sulcus, and is continuous, posteriorly, with the anterior central gyrus. The middle part, called also the *pars triangularis*, lies between the anterior ascending and the anterior horizontal rami of the lateral fissure. The anterior part, which has been termed the *pars orbitalis*, is placed below and anterior to the anterior horizontal ramus of the lateral fissure, and it is continuous with the posterior orbital gyrus of the inferior surface (Fig. 152).

Additional Sulci of the Supero-lateral Surface of the Frontal Lobe.—There are four fairly constant sulci on the supero-lateral surface of the frontal lobe, besides those which intervene between its principal gyri; they are the paramedial, the middle, the fronto-marginal, and the diagonal.

The *paramedial sulcus* is either a continuous sulcus which lies between the supero-medial border and the superior frontal sulcus, and separates the superior frontal gyrus into upper and lower parts, or it is represented by a series of separate depressions (Fig. 137).

The *middle frontal sulcus* separates the middle frontal gyrus into upper and lower parts. It terminates anteriorly, close to the superciliary border of the hemisphere, in a transversely placed limb called the *fronto-marginal sulcus* (Fig. 152).

The *diagonal sulcus* lies parallel with the inferior part of the inferior precentral sulcus, in the posterior part of the inferior frontal gyrus, intervening between two structurally different parts of that portion of the gyrus.

The *Inferior Surface of the Frontal Lobe* forms the orbital or anterior part of the inferior surface of the hemisphere. It rests upon the roof of the orbit and the roof of the nose. It is bounded, anteriorly and laterally, by the superciliary border, and, medially, by the medial orbital border. Posteriorly, in the lateral part of its extent, its boundary is the stem of the lateral fissure, but, more medially, it is separated from the anterior perforated substance by a sulcus which has been named the *fissura prima*.

The *Sulci of the Inferior Surface of the Frontal Lobe* are the olfactory sulcus and the orbital sulci (Fig. 138).

Sulcus Olfactorius.—The olfactory sulcus lies parallel with, and a short distance from, the medial orbital border. It lodges the olfactory bulb and the olfactory tract.

Sulci Orbitales.—The orbital sulci are irregular in arrangement, but generally they assume, collectively, a somewhat H-shaped form, the transverse bar of the H being at right angles to the long axis of the hemisphere.

The *Gyri of the Inferior Surface of the Frontal Lobe* are the gyrus rectus and the orbital gyri.

Gyrus Rectus.—The gyrus rectus is the district medial to the olfactory sulcus, and it extends from the frontal pole to the anterior perforated substance. It is continuous, round the frontal pole, with the superior frontal gyrus, and it turns round the medial orbital border on to the medial surface of the hemisphere.

Gyri Orbitales.—The orbital gyri are medial, lateral, anterior and posterior. The medial and lateral are continuous with the anterior and posterior, both anteriorly and posteriorly.

The medial orbital gyrus lies between the olfactory sulcus and the medial limb of the H-shaped sulcus. The anterior and the posterior orbital gyri are respectively anterior and posterior to the transverse bar of the H-shaped sulcus; and the lateral gyrus is to the lateral side of the lateral limb of the sulcus.

The medial orbital gyrus is continuous with the superior frontal gyrus; the anterior orbital gyrus is in continuity with the middle frontal gyrus; and the lateral orbital gyrus, with the inferior frontal gyrus; whilst at the bottom of the stem of the lateral fissure the posterior orbital gyrus is separated from the temporal lobe by the lower part of the insula.

The medial surface of the frontal lobe will be examined at a later period; but the dissector should note that upon its medial surface are a part of the superior frontal gyrus, a part of the gyrus cinguli and a part of the paracentral lobule (Fig. 159).

Lobus Parietalis.—The parietal lobe appears on the supero-lateral and the medial surfaces of the hemisphere, and its lower portion forms the upper wall of the posterior horizontal ramus of the lateral fissure. The part on the medial surface which forms the precuneus, and takes part in the formation of the paracentral lobule and the gyrus cinguli, will be examined at a later period. The inferior portion partly abuts against the temporal lobe, along the superficial part of the posterior ramus of the lateral fissure, but, more deeply, it is in close relation with the insula, from which it is separated by the circular sulcus. The dissector should verify these facts by gently separating the lips of the posterior ramus of the lateral fissure.

The *Supero-lateral Surface of the Parietal Lobe* lies entirely under cover of the parietal bone, and is bounded, above, by the supero-medial border of the hemisphere; below, by the posterior ramus of the lateral fissure and by a line projected horizontally backwards from the point where that fissure turns upwards; anteriorly, by the central sulcus; and, posteriorly, by the lateral part of the parieto-occipital fissure and a line prolonged from it to the pre-occipital notch on the infero-lateral border of the hemisphere (Figs. 155, 177).

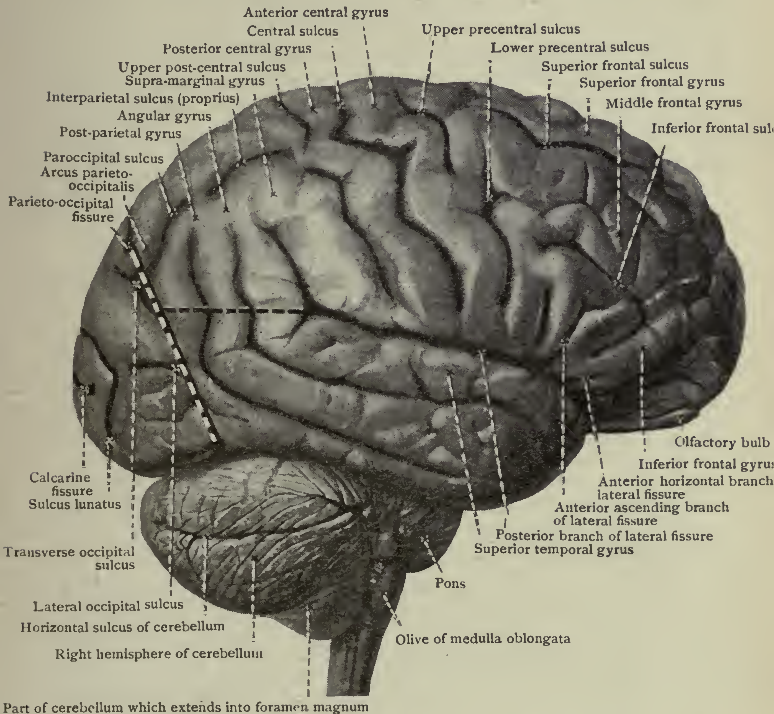


FIG. 155.—Lateral surface of Right Half of the Brain (semi-diagrammatic). The horizontal dotted line completes the separation between the parietal and temporal areas, and the oblique dotted line, which runs from the parieto-occipital fissure to the pre-occipital notch, separates the occipital from the parietal and temporal areas.

The Sulci of the Supero-lateral Surface of the Parietal Lobe.—The sulci of the supero-lateral surface of the parietal lobe are the post-central sulci, the interparietal sulcus proper, and the par-occipital sulcus.

Sulci Postcentrales.—There are two post-central sulci—a superior and an inferior. They are developed independently, and they run parallel with the central sulcus, from which they are separated by the posterior central gyrus. Not uncommonly, the two post-central sulci are continuous with one another in the adult; and either the one or the other may be continuous with the sulcus interparietalis proprius (Figs. 152, 155).

Sulcus Interparietalis Proprius.—The interparietal sulcus proper runs backwards, almost horizontally, about midway between the upper and lower borders of the supero-lateral surface of the parietal lobe. It separates the superior from the inferior parietal lobule, and it may be continuous, anteriorly, with one or other of the post-central sulci, and, posteriorly, with the par-occipital sulcus.

Sulcus Paroccipitalis.—In the adult, the par-occipital sulcus is either directly continuous with, or it commences close to, the posterior end of the sulcus interparietalis proprius. It runs backwards, past the lateral end of the parieto-occipital fissure, from which it is separated by a parieto-occipital annectant gyrus called the arcus parieto-occipitalis; and it terminates, in the occipital lobe, in the transverse occipital sulcus (Figs. 137, 152, 154).

In the past it was the custom to speak of an interparietal sulcus which consisted of a vertical, a horizontal and an occipital portion. The vertical part is the inferior post-central sulcus, the horizontal part is the sulcus interparietalis proprius, and the occipital part is the par-occipital sulcus.

The Gyri of the Supero-lateral Surface of the Parietal Lobe.—The subdivisions of the supero-lateral surface of the parietal lobe are the posterior central gyrus; the superior parietal lobule; and the supra-marginal, the angular, and the post-parietal gyri, which form collectively the inferior parietal lobule (Fig. 152).

Gyrus Centralis Posterior.—The posterior central gyrus lies between the central and the post-central sulci. Along its anterior face, which forms the posterior wall of the central sulcus, and along the adjacent part of the supero-lateral surface lies the main area of ordinary sensation (Fig. 153). It is continuous, above and below, with the anterior central gyrus, and posteriorly with the superior and inferior parietal lobules.

Lobulus Parietalis Superior.—The superior parietal lobule is bounded, anteriorly, by the superior post-central sulcus; posteriorly, by the parieto-occipital fissure; above, by the supero-medial border; and, below, by the sulcus interparietalis proprius. It is sometimes divided into anterior and posterior parts by a small sulcus called the *superior parietal sulcus.*

Lobulus Parietalis Inferior.—The anterior and the superior boundaries, and the anterior part of the inferior boundary of the inferior parietal lobule are quite definite, but the posterior boundary and the posterior part of the inferior boundary are arbitrary lines. The superior boundary is the sulcus interparietalis proprius; the anterior boundary is the inferior post-central sulcus; the inferior boundary is formed by the posterior part of the posterior ramus of the lateral fissure, and an imaginary line drawn backwards from the point where the posterior ramus of the lateral fissure turns upwards, to a second imaginary line, drawn from the lateral part of the parieto-occipital fissure to the pre-occipital notch on the infero-lateral border. The last-mentioned line, and the lateral part of the parieto-occipital fissure form the posterior boundary of the parietal lobe, and separate it from the occipital lobe (Fig. 155).

The Sulci of the Inferior Parietal Lobule are the upturned ends of the posterior ramus of the lateral fissure, and the superior and middle temporal sulci, which extend from the temporal lobe into the inferior parietal lobule (Fig. 152).

The Gyri of the Inferior Parietal Lobule are three in number—the supra-marginal, the angular, and the post-parietal.

The *supra-marginal gyrus* surrounds the upturned end of the posterior ramus of the lateral fissure.

The *angular gyrus* surrounds the upturned end of the superior temporal sulcus; and, in a similar manner, the *post-parietal gyrus*, when it is well marked, surrounds the upturned end of the middle temporal sulcus. It is separated from the arcus parieto-occipitalis by the sulcus par-occipitalis.

Lobus Temporalis.—The temporal lobe appears on the lateral and the inferior surfaces of the hemisphere, and it forms the lower wall of the posterior ramus of the lateral fissure.

The Sulci on the Lateral Surface of the Temporal Lobe are the superior and the middle temporal sulci.

Sulcus Temporalis Superior.—The superior temporal sulcus lies parallel with the posterior ramus of the lateral fissure (Figs. 152, 155). It intervenes between the superior and the middle temporal gyri; and it consists of two genetically distinct portions—an anterior and a posterior, which sometimes remain separate, even in the adult.

Sulcus Temporalis Medius.—The middle temporal sulcus, which lies between the middle and the inferior temporal gyri, is very irregular in its mode of formation; not infrequently it is represented by two or more separate portions.

The Gyri of the Lateral Surface of the Temporal Lobe.—There are three gyri on the lateral surface of the temporal lobe—superior, middle, and inferior.

Gyrus Temporalis Inferior.—The inferior temporal gyrus lies below the middle temporal sulcus; it forms the temporal part of the infero-lateral border of the hemisphere, and will be seen again on the inferior surface of the temporal lobe, where it is separated from the fusiform gyrus by the inferior temporal sulcus.

Gyrus Temporalis Medius.—The middle temporal gyrus lies between the middle and the superior temporal sulci, and it is more or less continuous, posteriorly, with the angular and the post-parietal gyri.

Gyrus Temporalis Superior.—The superior temporal gyrus lies between the superior temporal sulcus and the posterior ramus of the lateral fissure, and it extends forwards to the tip of the temporal pole of the hemisphere (Fig. 152).

The Upper Part of the Temporal Lobe, which forms the lower wall of the posterior ramus of the lateral fissure, is in relation with the insula and the lower parts of the parietal and frontal lobes. The dissector can display it by gently separating the lips of the fissure, and upon it two gyri, running backwards and medially, will be seen; they are the *anterior transverse temporal gyrus* (Heschl's convolution) and the *posterior transverse temporal gyrus*. The anterior transverse temporal gyrus and the portion of the posterior part of the superior temporal gyrus adjacent to its lateral end constitute the *acoustic area* of the brain cortex (Fig. 153).

The Inferior Surface of the Temporal Lobe forms the greater part of the posterior portion of the inferior surface of the hemisphere, and in brains hardened *in situ* it is marked, anteriorly, by an obvious depression due to the eminentia arcuata of the anterior surface of the petrous part of the temporal bone.

The Fissures and Sulci of the Inferior Surface of the Temporal Lobe are: (1) part of the chorioidal fissure (Fig. 138); (2) the collateral fissure; (3) the stem of the calcarine fissure; (4) the rhinal fissure; and (5) the inferior temporal sulcus.

Fissura Chorioidea.—The chorioidal fissure forms the anterior portion of the medial or upper boundary of the posterior part of the inferior surface of the hemisphere. In the region of the fissure the wall of the cavity of the hemisphere is reduced to a thin layer of epithelium, and the fissure is produced by the invagination of the epithelial wall, into the inferior cornu of the lateral ventricle of the hemisphere, by a vascular fold of pia mater.

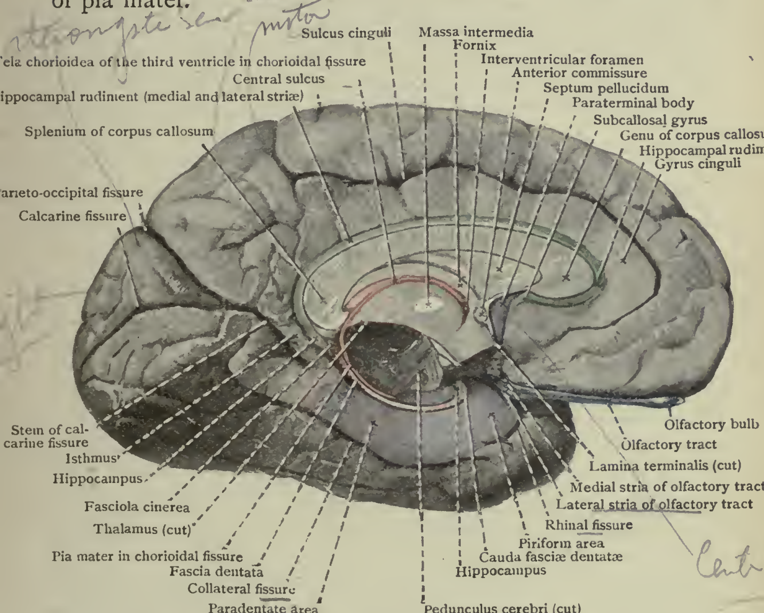


FIG. 156.—Diagram showing portions of the Hippocampus and associated parts. The green line represents the indusium, which is a rudiment of the hippocampal formation.

Below the posterior part of the chorioidal fissure the stem of the *calcarine fissure* reaches the inferior surface, after cutting across the medial occipital border of the hemisphere.

Fissura Collateralis.—The collateral fissure is placed more laterally and on a lower level than the chorioidal fissure. It lies below the stem of the calcarine fissure and extends forwards beyond its anterior extremity (Figs. 156, 159).

The Rhinal Fissure lies anterior to and slightly above or medial to the anterior end of the collateral fissure.

Sulcus Temporalis Inferior.—The inferior temporal sulcus is below and lateral to the collateral fissure.

The Gyri of the Inferior Surface of the Temporal Lobe are the hippocampal gyrus, the lingual gyrus, the fusiform gyrus, and a part of the inferior temporal gyrus.

Gyrus Hippocampi.—The hippocampal gyrus is bounded by the rhinal and collateral fissures, infero-laterally, and the chorioidal fissure, supero-medially. The posterior end of the hippocampal gyrus is continuous, below the stem of the calcarine fissure, with the anterior part of the lingual gyrus, and, in front of the anterior end of the calcarine fissure, it is connected by means of a narrow bridge, called the *isthmus*, with the posterior part of the gyrus cinguli, which embraces the corpus callosum, and which forms, with the isthmus and the hippocampal gyrus, a continuous fold of the cortex termed the *gyrus fornicatus.* The anterior end of the hippocampal gyrus is turned upwards and backwards, and is called the *uncus* (Fig. 138).

If the upper or medial border of the hippocampal gyrus, behind the uncus, is displaced downwards a vertically notched ridge of grey matter will be brought into view; it is the *fascia dentata*, and it will be seen to much better advantage when the inferior cornu of the lateral ventricle is studied. The portion of the hippocampal gyrus which lies above and medial to the rhinal fissure, including the uncus, is *the piriform area*, and it is closely associated with the sensation of smell. The more posterior part of the hippocampal gyrus forms the *paradentate area* (Fig. 156).

Gyrus Lingualis.—The portion of the lingual gyrus which appears on the inferior surface of the temporal lobe lies between the stem of the calcarine fissure and the posterior part of the collateral fissure (Figs. 138, 159). It is continuous anteriorly with the hippocampal gyrus, and, posteriorly, its upper part crosses the medial occipital border of the hemisphere and forms part of the medial surface of the occipital lobe. It constitutes a portion of the striate area or area of vision.

Gyrus Fusiformis.—The fusiform gyrus lies between the collateral fissure and the inferior temporal sulcus. It is continued posteriorly to the inferior surface of the occipital lobe.

Gyrus Temporalis Inferior.—Only a part of the inferior temporal gyrus appears on the inferior surface of the temporal lobe; the remainder forms the infero-lateral border of the hemisphere, in the temporal region, and a part of the lateral surface of the temporal lobe.

Lobus Occipitalis.—The occipital lobe forms part of the supero-lateral, part of the inferior, part of the medial surface of the hemisphere, and the occipital pole. Its medial surface, which will be seen more clearly at a later stage, is definitely separated from the medial surface of the parietal lobe by the parieto-occipital fissure. The boundary which separates its supero-lateral surface from the adjacent parts of the parietal and temporal lobes is the small, lateral part of the parieto-occipital fissure, and a line drawn from that fissure to the pre-occipital notch on the infero-lateral border of the hemisphere. It is, therefore, largely artificial; and there is no natural line of demarcation between the inferior surface of the occipital lobe and the inferior surface of the temporal lobe (Figs. 138, 156, 159).

The Sulci and Fissures of the Supero-lateral Surface of the Occipital Lobe.—On the posterior part of the supero-lateral surface of the occipital lobe is the terminal part of the *calcarine fissure* which curls round the occipital pole, from the medial to the lateral surface. The portion of the brain cortex which immediately surrounds the extremity of the calcarine fissure is part of the striate or visual area of the cortex (Figs. 152, 154, 155).

Immediately anterior to the end of the calcarine fissure is a curved sulcus, convex forwards, called the *sulcus lunatus*. It forms the anterior boundary of the visual area on the supero-lateral surface of the hemisphere. Anterior to the sulcus lunatus, and at right angles with it, is the *sulcus occipitalis lateralis*, which divides the larger, anterior part of the supero-lateral surface of the occipital lobe into an upper and a lower portion. Passing backwards from the parietal lobe into the upper portion of the occipital lobe is the sulcus par-occipitalis. It ends posteriorly in a sulcus, the *sulcus occipitalis transversus*, which is at right angles with the sulcus par-occipitalis. In some cases a small sulcus, the *sulcus occipitalis paramedialis*, is recognisable, parallel with and close to the supero-medial border of the occipital lobe (Figs. 152, 154). When it is present the supero-lateral surface of the occipital lobe is separated, by it and the lateral occipital sulcus, into superior, middle, and inferior gyri.

The Sulci and Gyri of the Inferior Surface of the Occipital Lobe.—The posterior part of the collateral fissure extends backwards from the temporal into the occipital lobe, separating the lingual gyrus from the posterior part of the fusiform gyrus, both of which enter into the formation of the inferior surface of the occipital lobe (Figs. 138, 156).

After the study of the fissures, sulci, and gyri of the superolateral and inferior surfaces of the hemispheres is completed

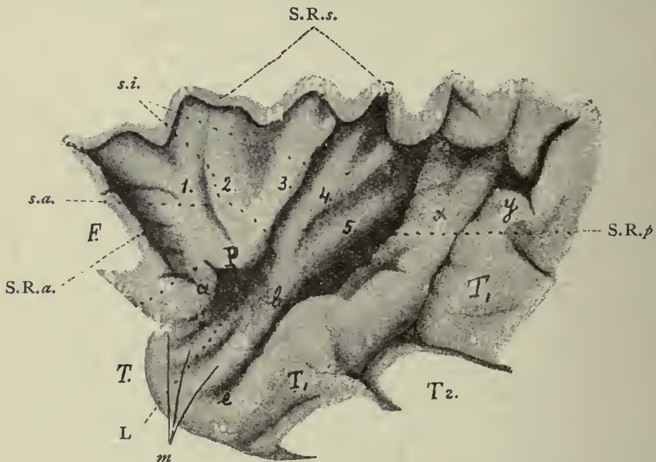


FIG. 157.—Fissures and Gyri on the Surface of the Insula. (Eberstaller.)

1, 2, and 3. Three short gyri on the frontal part of the insula.
4 and 5. Two long gyri on parietal part.
S.R.*a.* Anterior part of circular sulcus.
S.R.*s.* Superior part of circular sulcus.
S.R.*p.* Inferior part of circular sulcus.
L. Limen insulæ.
P. Pole of the insula.
F. Orbital operculum (for the most part removed).
T. Temporal pole.
T1. Superior temporal gyrus.
T2. Middle temporal gyrus.
x.y. Transverse temporal gyri.
s.i. Sulcus centralis insulæ.
s.a. Sulcus præcentralis insulæ.
m. Gyri on deep surface of temporal pole.

the dissector should separate the margins of the lateral fissure from one another, and examine the insula, which lies under cover of the boundaries of the fissure; or if the brain is so hardened that the margins of the fissure cannot be drawn apart the dissector should cut away the portions of the frontal, parietal, and temporal lobes which overlap and conceal the insula.

Insula (O.T. **Island of Reil**).—The insula is a pyramidal area of the hemisphere which lies on a deeper plane than the remainder of the surface of the hemisphere; it is hidden from view by the adjacent margins of the frontal, parietal, and temporal lobes, which overlap it and constitute the opercula of the *fossa lateralis*. The fossa lateralis is the depression, at the bottom of the lateral fissure, in which the insula lies. Round the anterior, superior, and posterior borders of the insula runs a sulcus, called the *sulcus circularis*. It separates the insula from the adjacent parts of the hemisphere. At the apex or lowest part of the insula there is a rounded fold of the brain substance; it is directly connected with the lateral of the two striæ which extend from the posterior end of the olfactory tract and with the piriform area of the hippocampal gyrus, and it forms part of the olfactory area of the hemisphere. The region in which it is situated is known as the *limen insulæ*.

The surface of the insula is divided into an anterior or frontal portion and a posterior or parietal portion by the *sulcus centralis insulæ*, which is in a plane parallel with the plane of the central sulcus on the supero-lateral surface of the hemisphere. On both portions of the insula there are two or more gyri.

At this stage, the dissector should study the portion of the middle cerebral artery which was left *in situ* when the membranes were removed from the hemisphere (p. 387). He will find that it passes along the stem of the lateral fissure, crosses the limen insulæ, and breaks up on the surface of the insula into the terminal branches which were noted on the supero-lateral surface of the hemisphere (p. 388).

When the positions of the terminal branches of the middle cerebral artery have been studied, the vessels and the surrounding membranes may be removed.

Lobus Olfactorius.—Each olfactory lobe consists of several parts; they are: (1) the olfactory bulb; (2) the olfactory tract; (3) the olfactory striæ, medial and lateral; and (4) the olfactory trigone. The *olfactory bulb*, which is the most anterior part of the olfactory region of the brain, lies on the lower surface of the frontal lobe, in the anterior part of the olfactory sulcus. On its lower surface it receives the olfactory nerves, which arise in the olfactory mucous membrane of the nose and terminate in the olfactory bulb. They are about twenty in number. The olfactory bulb is continuous, posteriorly, with the *olfactory tract*, a triangular prismatic band which runs backwards, in the olfactory sulcus, to the anterior border of the anterior perforated substance, where it ends in a pyramidal elevation, the *trigonum olfactorium.* From the lateral angle of the olfactory trigone the *stria olfactoria lateralis* passes, backwards and laterally, along the lateral margin of the anterior perforated substance and across the limen insulæ to the piriform area of the hippocampal gyrus (Fig. 162). The dissector should understand that under cover of the lateral olfactory stria there is a layer of grey matter which represents the anterior part of the piriform area.

Dissection.—To display the course of the lateral olfactory stria it will be necessary to raise the temporal pole and, possibly, it may be necessary to cut away the tip of the temporal lobe; but that must be done on one side only.

From the medial angle of the olfactory trigone the *medial olfactory stria* passes round the posterior end of the gyrus rectus to the medial aspect of the hemisphere, towards the *subcallosal gyrus.* The subcallosal gyrus is situated on the under surface of the anterior part of the corpus callosum, and it must be looked for at a later stage of the dissection (Figs. 156, 159).

Dissection.—A dissection should now be made with the object of displaying the upper surface of the corpus callosum. For that purpose the upper portion of the hemisphere, on one side, must be removed, and when that is done it will be possible to study the gyri, fissures, and sulci on the medial surface of the opposite hemisphere.

With a long knife slice off the upper part of the right hemisphere down to the level of the sulcus cinguli on the medial surface (see Fig. 161). The white medullary centre of the hemisphere, enclosed within the grey cortex, which is brought into view when the section is made, is termed the *centrum semi-ovale.* From the centrum semi-ovale prolongations of the white matter pass into all the surrounding gyri (Fig. 161).

A transverse incision must now be made through the centre of the gyrus cinguli, which forms the medial boundary of the semi-oval centre; then the anterior and posterior parts of the gyrus cinguli must be torn away from the hemisphere in a lateral direction. If that is done successfully the manner in which the fibres of the corpus callosum enter the hemisphere will be demonstrated (Fig. 161).

If the student is dissecting the brain for the second time he should not use the knife at all in carrying out this dissection. The upper part of the hemisphere to the level of the gyrus cinguli should be torn off and then the gyrus cinguli may be treated in the same manner. By that expedient the fibres of the corpus callosum may be traced into individual gyri.

Cingulum.—Examine the deep surface of the gyrus cinguli, which has been torn away, and note that a large bundle of longitudinally directed fibres is embedded in its substance. The bundle is the cingulum. It is a longitudinal association bundle, composed of several systems of fibres which run only for short distances within it and then pass into the adjacent parts of the gyrus fornicatus. It curves round the convexity of the corpus callosum, commencing, in front, at the anterior perforated substance and terminating, posteriorly, in the

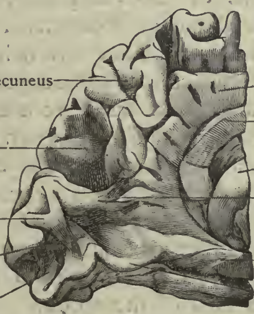


FIG. 158.—Posterior part of medial surface of the Left Hemisphere. The calcarine and the parieto-occipital fissures are widely opened up to show the deep gyri within them.

hippocampal gyrus (Fig. 156). It can be easily displaced from its bed by the exercise of a very slight degree of traction.

The fissures and sulci and gyri on the medial surface of the left hemisphere should now be studied.

The Fissures and Sulci on the Medial Surface of the Hemisphere are—the medial part of the parieto-occipital fissure; the posterior part of the calcarine fissure; the callosal sulcus; the sulcus cinguli; the subparietal sulcus; and, possibly, the upper end of the central sulcus.

Fissura Parieto-occipitalis.—The medial part of the parieto-occipital fissure descends on the posterior part of the medial surface of the hemisphere between the occipital and parietal lobes. It terminates a short distance behind the posterior end of the corpus callosum, and close to the medial occipital border, by joining the calcarine fissure. If the dissector separates the margins of the fissure he will be able to convince himself that the union of the two fissures occurs only near the surface, and that the lower end of the deep part of the parieto-occipital fissure is separated from the calcarine fissure by a submerged ridge called the *gyrus cunei.*

Fissura Calcarina.—The stem or anterior part of the calcarine fissure has already been seen on the inferior surface of the hemisphere (p. 413). It crosses the medial occipital border and joins the parieto-occipital fissure on the medial surface of the occipital lobe. Then it passes backwards to the occipital pole, round which it turns; and it ends, on the supero-lateral surface of the occipital lobe, in a terminal bifurcation. If the dissector separates the margins of the fissure he will find that, immediately behind its union with the parieto-occipital fissure, a submerged ridge, the *cuneo-lingual gyrus*, separates the anterior from the posterior portion of the calcarine fissure. The ridge is an indication that the two parts of the calcarine fissure arose separately and became combined at a later period both ontogenetically and phylogenetically.

At this stage the dissector should make a frontal section through the posterior part of the right occipital lobe, and then examine the surface of the section of the grey matter in the region of the posterior part of the calcarine fissure. If the brain substance is in a state of good preservation he will find a distinct white line, called the *stria Gennari*, which cuts the grey matter into inner and outer parts, and which is not present in the neighbouring regions. The portion of the cortex marked by the line is called the *area striata*; it is the visual area of the cortex, and the line indicates that the portion of the cortex in which it lies is associated with sight. It is found in both walls of the posterior part of the calcarine fissure and the adjacent parts of the cuneus and the lingual gyrus which bound the fissure, but it occurs only on the lower lip of the anterior part of the calcarine fissure, which is situated, therefore, on the boundary line between the visual and non-visual portions of the cortex.

Sulcus Corporis Callosi.—The callosal sulcus runs round the convex outline of the corpus callosum, separating the corpus callosum from the gyrus cinguli.

Sulcus Cinguli.—The sulcus cinguli runs parallel with the callosal sulcus and is separated from it by the gyrus cinguli.

It commences below the anterior end of the corpus callosum and runs at first forwards and upwards and then backwards, parallel with the supero-medial border of the hemisphere, to a point somewhat behind the upper end of the posterior central gyrus, where it turns upwards, cuts the supero-medial border, and terminates on the supero-lateral surface of the hemisphere. It separates the gyrus cinguli, which embraces the anterior and upper parts of the corpus callosum, from the superior frontal gyrus and the upper ends of the anterior and the posterior central gyri (Figs. 159, 160).

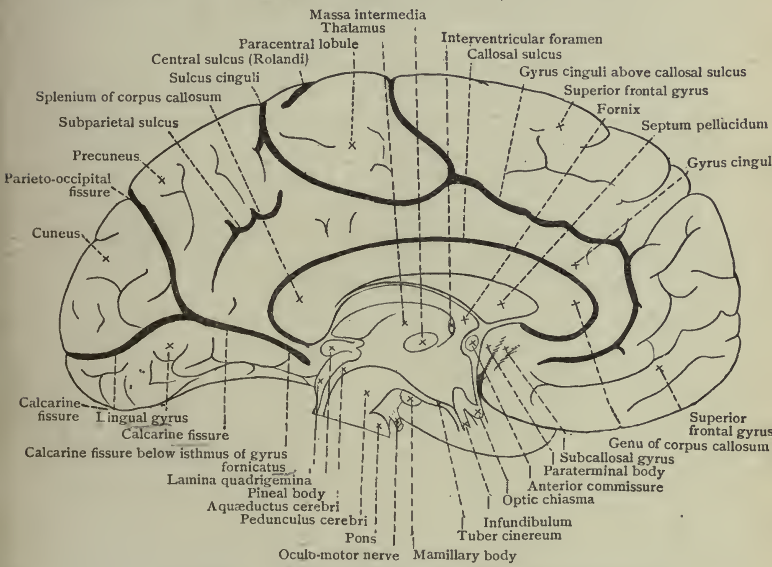


FIG. 159.—Medial surface of Left Hemisphere (semi-diagrammatic).

Sulcus Subparietalis.—Behind the posterior end of the sulcus cinguli, and sometimes continuous with it, is the subparietal sulcus. It separates the medial part of the superior parietal lobule, which is called the precuneus, from the posterior part of the gyrus cinguli (Figs. 159, 160).

The Gyri of the Medial Surface of the Hemisphere.—The gyri on the medial surface of the hemisphere are the superior frontal gyrus; the upper ends of the anterior and the posterior central gyri, the precuneus, the cuneus, part of the lingual gyrus, the gyrus cinguli, and part of the gyrus rectus.

Gyrus Frontalis Superior.—The superior frontal gyrus has been seen already on the supero-lateral surface of the hemisphere (p. 406). It forms that part of the medial surface which lies between the sulcus cinguli and the supero-medial border, and anterior to the upper end of the anterior central gyrus.

On its antero-inferior part are two or three secondary gyri which run antero-posteriorly or forwards and slightly upwards; they are known as the *rostral gyri*. The posterior end of the medial aspect of the superior frontal gyrus is separated from the upper end of the anterior central gyrus by an offshoot from the sulcus cinguli.

Lobulus Paracentralis.—The paracentral lobule corresponds in position with the upper ends of the anterior and posterior central gyri. It is bounded, posteriorly, by the upturned end of the sulcus cinguli; anteriorly, by an offset from the sulcus cinguli. Its frontal portion is part of the motor area of the cerebrum.

Præcuneus.—The precuneus is the medial part of the superior parietal lobule of the supero-lateral surface (p. 410). It is bounded, behind, by the parieto-occipital fissure; in front, by the upturned end of the sulcus cinguli; below, by the sulcus subparietalis; and, above, by the supero-medial border of the hemisphere.

Cuneus.—The cuneus forms the greater part of the medial surface of the occipital lobe. It is bounded, anteriorly, by the parieto-occipital fissure; below, by the calcarine fissure; and, above and behind, by the supero-medial border of the hemisphere.

Gyrus Lingualis.—The lingual gyrus forms the lowest part of the medial surface of the occipital lobe. On that surface it lies between the calcarine fissure and the medial occipital border, which separates the medial from the posterior part of the inferior surface of the hemisphere. Anteriorly, it crosses the medial occipital border and passes to the inferior surface, where it has already been seen (Fig. 138).

After the study of the fissures, sulci, and gyri of the medial surface of the hemisphere is completed, the dissector must remove the upper part of the left hemisphere above the level of the corpus callosum and anterior to the parieto-occipital fissure, but the fissure itself, and the part of the brain behind it, should be left intact so that a repeated study of the calcarine fissure and its boundaries, and the relationships of the occipital and temporal lobes on the inferior surface, can be made at a later stage of the dissection.

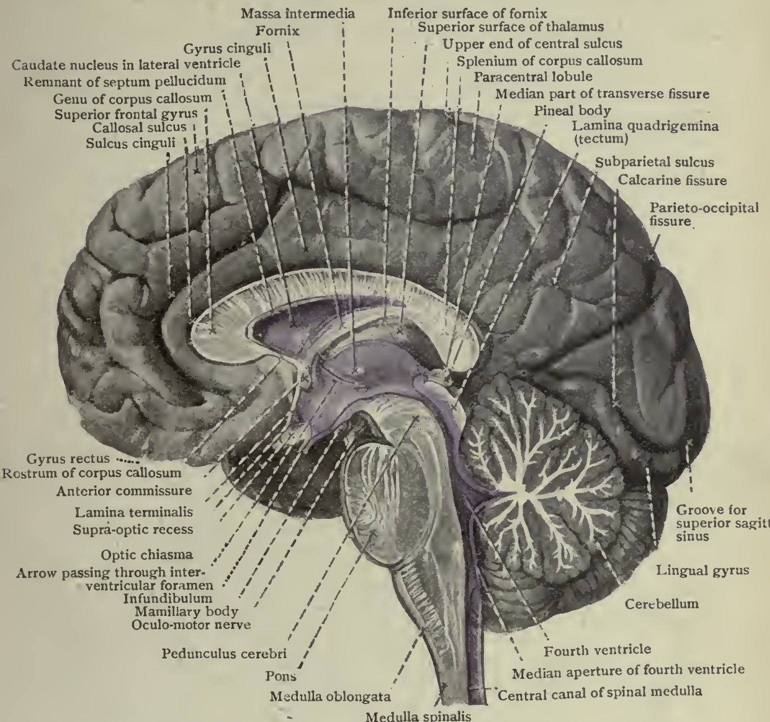


FIG. 160.—Medial surface of the Right Hemisphere, and the structures seen after a sagittal section has been made through the Corpus Callosum, the Fornix, the Diencephalon, the Mesencephalon, and the Rhombencephalon, and after the Septum Pellucidum has been removed from between the Corpus Callosum and the Fornix. The arrow passes through the interventricular foramen from the right lateral ventricle to the third ventricle, where it lies in the hypothalamic sulcus in the lateral wall of the third ventricle.

When the upper parts of both hemispheres have been removed the upper surface of the corpus callosum will be exposed; and it will be evident that the corpus callosum unites into one mass the medullary centres of the two hemispheres. The term *centrum ovale* is applied to the continuous white area which consists of the corpus callosum and the medullary centres of the two hemispheres.

Corpus Callosum.—The corpus callosum is the great transverse commissure of the cerebrum. It is placed nearer the anterior than the posterior end of the brain, and it unites

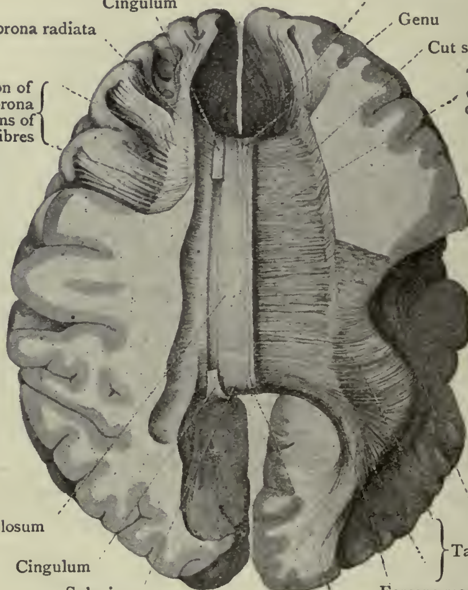


FIG. 161.—The Corpus Callosum exposed from above and the right half dissected to show the course taken by the fibres.

the medial surfaces of the two cerebral hemispheres throughout very nearly a half of their antero-posterior length (Fig. 161).

Its *upper surface*, which forms the floor of the central part of the longitudinal fissure, is convex antero-posteriorly and concave from side to side. In the posterior part of its extent it is touched, in the median plane, by the falx cerebri; anteriorly, that fold of dura mater does not pass so deeply into the fissure. On each side of the fissure the corpus callosum is covered by the gyrus cinguli (O.T. callosal gyrus). The upper surface of the corpus callosum is coated by an exceedingly thin layer of grey matter, called the *indusium griseum*, which is continuous, at the bottom of the callosal sulcus, with the grey cortex of the hemisphere. Associated with the indusium, on each side of the median plane, are two delicate longitudinal bands of fibres called the striæ longitudinales medialis and lateralis. The *stria longitudinalis medialis* is the more strongly marked of the two, and it is separated from its fellow of the opposite side by a faint median furrow. The *stria longitudinalis lateralis* is placed more laterally. So

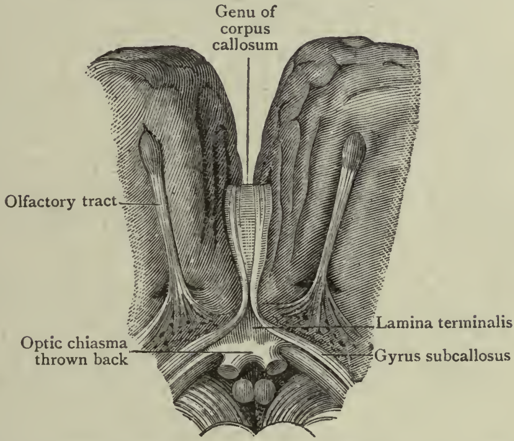


FIG. 162. — Anterior end of the Corpus Callosum and the Subcallosal Gyri as seen from below when the frontal lobes of the hemispheres are slightly separated from each other. (From Cruveilhier.)

thin is the indusium that the transverse direction of the bundles of callosal fibres can be easily seen through it.

The striæ, with the thin layer of grey matter associated with them, represent a gyrus called the *gyrus supracallosus*.

The two *extremities* of the corpus callosum (Fig. 160) are greatly thickened, whilst the middle part, the *truncus* (O.T. *body*), is considerably thinner. The thick posterior end, which is full and rounded, lies over the mesencephalon, and extends backwards as far as the highest point of the cerebellum. It is called the *splenium*. The anterior end, which is less thick than the posterior, is folded, downwards and backwards, upon itself, and is called the *genu*. The recurved lower portion of the anterior part of the corpus callosum rapidly thins as it passes backwards, and is termed the *rostrum.* The fine terminal edge of the rostrum is connected with the lamina terminalis (Fig. 160).

Both the lateral and the medial longitudinal striæ and the indusium, which lie upon the upper surface of the corpus callosum, turn downwards, round the splenium, and become continuous, below it, with the attenuated posterior part of the *hippocampus*, a structure which will be seen, later, in the inferior horn of the lateral ventricle. Immediately above the union of the indusium with the hippocampus there is a narrow ridge of grey matter, called the *fasciola cinerea*, which is the posterior, terminal part of the fascia dentata (Fig. 156). Anteriorly, the striæ and the indusium pass round the genu, and then along the under surface of the rostrum until they terminate in the *gyrus subcallosus* of the corresponding side. The gyrus subcallosus is a ridge which descends from the rostrum of the corpus callosum and passes towards the medial olfactory stria and the substantia perforata anterior (Fig. 160).

Fibres of the Corpus Callosum.—The transverse fibres of the corpus callosum, as they enter the white medullary centre of the cerebral hemisphere, radiate from each other towards various parts of the cerebral cortex. This radiation is called the *radiatio corporis callosi.* The more anterior of the fibres which compose the genu of the corpus callosum sweep forwards, in a series of curves, towards the frontal pole of the hemisphere. They form the *forceps minor.* A large part of the splenium, forming a solid bundle termed the *forceps major*, bends suddenly and abruptly backwards into the occipital lobe. Fibres from the trunk of the corpus callosum and also from the splenium curve round the lateral ventricle and form a very definite stratum called the *tapetum.* The tapetum is a thin layer, of the medullary centre of the hemisphere, which forms the roof and lateral wall of the posterior horn, and the lateral wall of the posterior part of the inferior horn of the lateral ventricle.

Ventriculus Lateralis.

The lateral ventricle, in the interior of the cerebral hemisphere, should now be opened up on each side. The corpus callosum, which forms the roof of the central part (O.T. body) and anterior horn of this cavity, must, therefore, be partially removed.

Dissection.—Make a longitudinal incision, through the corpus callosum, about 6 mm. (*a quarter of an inch*) or less from the median plane, on each side. The central portion of the corpus callosum which lies between the incisions is to be kept in position. The lateral portions must be turned laterally and detached completely. As that is being done, it will become evident that the lower part of the splenium, which is prolonged into the forceps major, is, in reality, a portion folded forwards in close apposition with the under surface of the posterior end of the corpus callosum. Be careful to leave the forceps major in its place (Fig. 163).

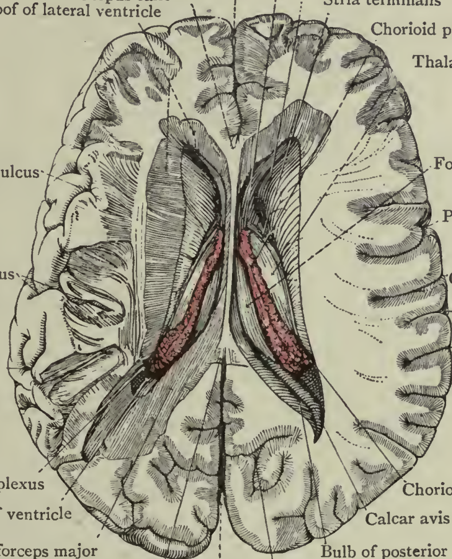


FIG. 163.—Dissection of the Lateral Ventricles of the Brain. On the right side the hemisphere was cut horizontally at the level of the junction of the lateral wall with the roof of the ventricle. On the left side the part of the hemisphere above the corpus callosum was torn obliquely away; then the corpus callosum was cut through from above.

The central part and the anterior horn of the ventricle are now exposed; but the cavity of the ventricle runs backwards into the occipital lobe in the form of a posterior horn, and downwards and forwards into the temporal lobe as the inferior horn. The posterior horn should, at present, be opened on the right side only. Carry the knife backwards through the medullary substance which forms the roof of the cavity, and remove a sufficient amount of the roof to give a complete view of the interior of the cavity. Greater difficulty will be experienced in opening up the inferior horn. Place the point of the knife in the upper part of the horn, where it joins the central part of the ventricle, and carry the blade forwards and downwards, through the lateral part of the temporal lobe, towards the

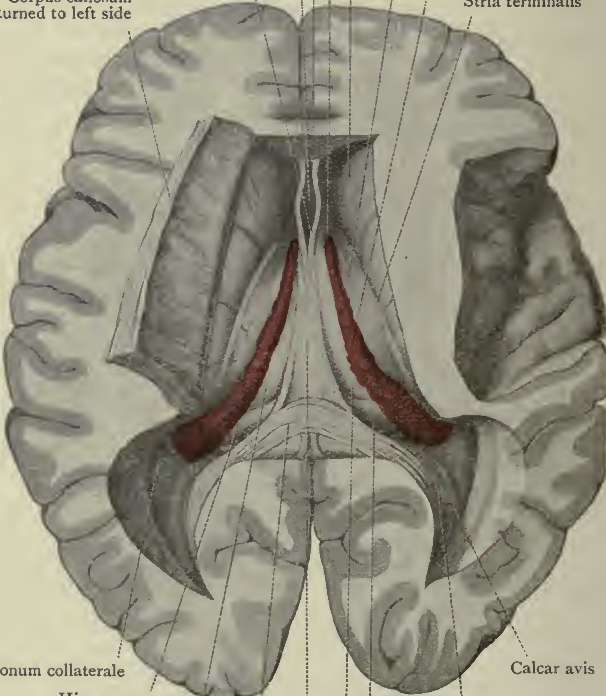


FIG. 164.—Dissection to show the Lateral Ventricles. The trunk of the corpus callosum has been detached from the genu and the splenium and turned over to the left.

temporal pole, following the course of the cavity, which corresponds, very nearly, with the course of the superior temporal sulcus. The lateral wall of the inferior horn is thus incised, and a sufficient amount of the lateral part of the temporal lobe

must be removed to give a view of the cavity. The dissection necessitates the removal of the temporal operculum, but the surface of the insula should be preserved from injury.[1]

Lateral Ventricle.—When the dissection is completed, the dissector cannot fail to note that each cerebral hemisphere is hollow. The cavity in the interior is called the lateral ventricle. It is lined with a thin dark-coloured layer of epithelium which is termed the *ependyma*. In certain places its walls are in apposition with each other, but in other

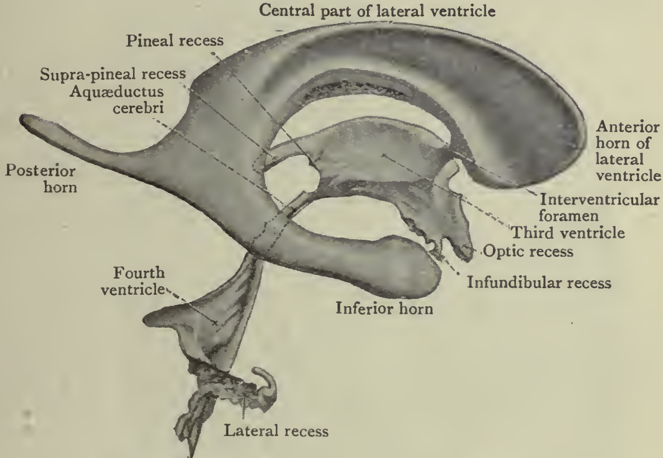


FIG. 165.—Cast of the Ventricles of the Brain. (From Retzius.)

localities spaces of varying capacity, and containing cerebro-spinal fluid, are left between the boundary walls. The lateral ventricle communicates with the third ventricle of the brain by means of a small foramen which is termed the *interventricular foramen* (O.T. *foramen of Monro*) (Figs. 160, 165). That aperture, which is just large enough to admit a crow-quill, lies at the anterior end of the thalamus, and posterior to the column of the fornix (O.T. anterior pillar). To find the aperture, the dissector should note the rough fringe of vascular pia mater which lies on the floor of the ventricle, and he should follow the fringe forwards to its passage into the foramen.

The shape of the lateral ventricle is very irregular, but it

[1] If the hemispheres have already been separated from one another the dissection must be carried out on each side separately.

is readily understood when a cast of the cavity is examined (Fig. 165). It is composed of a central part (O.T. body)

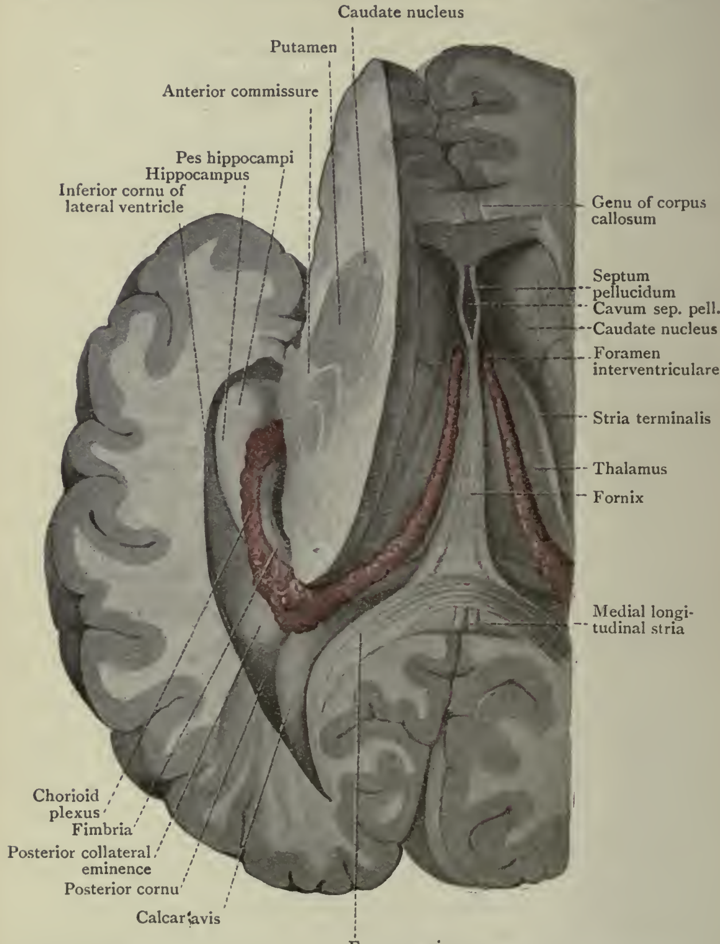


FIG. 166.—Dissection to show the Posterior and Inferior Cornua of the Lateral Ventricle on the left side.

and three horns, viz., an anterior, a posterior, and an inferior horn. The *anterior horn* is that part of the cavity which lies anterior to the interventricular foramen. The central part is the portion of the ventricle which extends from the interventricular foramen to the splenium of the corpus callosum. At the level of the splenium the posterior and inferior horns diverge from the posterior end of the central part. The *posterior horn* curves backwards and medially into the occipital lobe. It is very variable in its length and capacity. The *inferior horn* passes, with a bold sweep, round the posterior end of the thalamus, and then tunnels, downwards and forwards, through the temporal lobe, towards the temporal pole (Fig. 166).

Behind the anterior horn the floor of the central part of the ventricle is fully exposed and the following parts should be distinguished. (1) Extending backwards and laterally from the interventricular foramen is the vascular fringe called the *chorioid plexus of the lateral ventricle.* Posteriorly it descends into the inferior horn. (2) Medial to the chorioid plexus is the upper surface of the *body of the fornix.* Its posterior extremity, on each side, becomes a crus of the fornix, which accompanies the chorioid plexus into the inferior horn, where it terminates in the fimbria of the hippocampus. (3) Lateral to the chorioid plexus is a part of the *upper surface of the thalamus.* (4) Running along the lateral margin of the thalamus, in a shallow sulcus, is a white strand called the *stria terminalis.* It descends posteriorly into the roof of the inferior horn. (5) Lateral to the stria terminalis lies the convex upper surface of the body of the caudate nucleus.

Dissection.—When the parts mentioned have been identified, the central part of the corpus callosum, which is still in position, should be carefully raised to display the *septum pellucidum*, which descends from the lower surface of the corpus callosum to the upper aspect of the fornix, and so intervenes between the lateral ventricles of the opposite sides, forming the medial wall of the central part and the anterior cornu of each ventricle. Whilst the central part of the corpus callosum is still elevated the fornix should be followed forwards. It will be found to divide into two rounded bundles, called the *columns of the fornix*, which descend, one on each side, in front of the corresponding interventricular foramen (Fig. 160).

Plexus Chorioideus Ventriculi Lateralis.—The chorioid plexus of each lateral ventricle is a plexus of blood vessels enclosed in the lateral margin of a triangular fold of pia mater called the *tela chorioidea of the third ventricle.* The body of the fold is concealed at present. It will be displayed at a later stage of the dissection (Fig. 174).

Cornu Anterius Ventriculi Lateralis.—The anterior horn forms the anterior part of the cavity, and it extends forwards, laterally and downwards in the frontal lobe. When seen in frontal section it presents a triangular outline. The floor is narrow and is formed by the white matter of the orbital part of the frontal lobe. From it the medial and lateral walls ascend to the roof, which is formed by the under surface

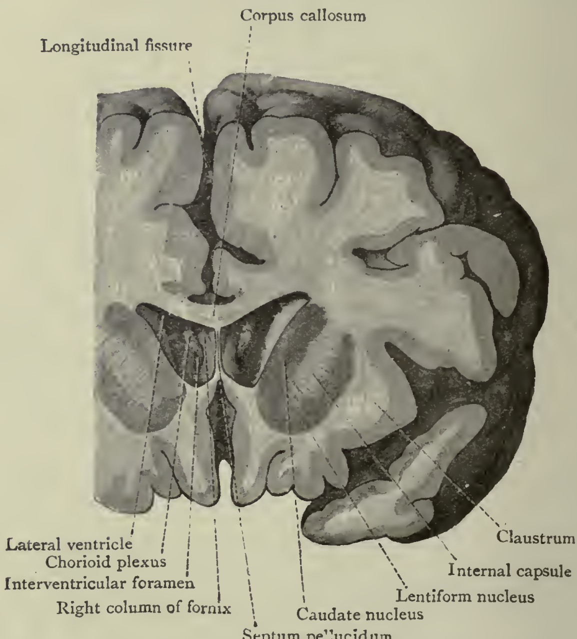


FIG. 167.—Frontal section through the Cerebrum through the anterior part of the lentiform nucleus. Seen from the anterior aspect.

of the corpus callosum. The vertical medial wall is the anterior part of the septum pellucidum, which separates the anterior horns of the opposite sides from one another. The in-bulging lateral wall is formed by the head of the caudate nucleus (Fig. 167).

Pars Centralis Ventriculi Lateralis.—The central part of the ventricle likewise is *roofed* by the corpus callosum. On the *medial side* it is bounded by the posterior part of the septum pellucidum, and more posteriorly by the attachment of the fornix to the under surface of the corpus callosum, behind the posterior end of the septum pellucidum. On the *lateral side* it is closed by the meeting of the roof and the floor of the cavity.

In the *floor* are several important objects which have already been referred to. Latero-medially, and, at the same time, to some extent from before backwards, they are—(1) the caudate nucleus; (2) a groove extending obliquely, backwards

FIG. 168.—Frontal section showing immediate relations of Lateral and Third Ventricles. (Part of Fig. 188 enlarged.)

and laterally, between the caudate nucleus and the thalamus, in which are placed the vena terminalis (O.T. vein of corpus striatum) and a white band called the stria terminalis (O.T. tænia semicircularis); (3) a portion of the upper surface of the thalamus; (4) the chorioid plexus; (5) the thin, sharp edge of the fornix.

The *caudate nucleus* lies in the lateral part of the floor of the central part of the lateral ventricle, and it narrows very rapidly as it passes backwards.

The *vena terminalis* is seen through the ependyma in the groove between the caudate nucleus and the thalamus. It joins the internal cerebral vein (O.T. vein of Galen) at the interventricular foramen. In the same groove is placed the stria terminalis—a narrow band of white matter, which bends downwards and disappears from view in the region of the interventricular foramen. Its fibres ultimately reach the substantia perforata anterior, in which they end.

The portion of the upper surface of the *thalamus* which appears in the floor of the lateral ventricle is, in great part, overlaid by the *chorioid plexus* of the lateral ventricle. The plexus is a rich vascular fringe which appears from under cover of the sharp edge of the fornix. It is continuous anteriorly, through the interventricular foramen, with the corresponding chorioid plexus of the opposite side; whilst

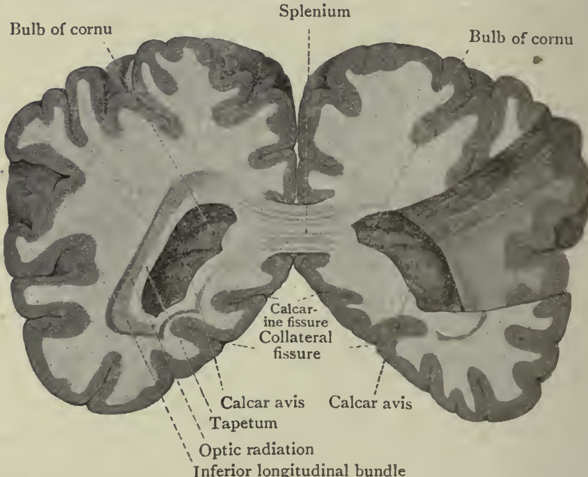


FIG. 169.—Frontal section through the Posterior Horns of the Lateral Ventricles.

posteriorly, it is carried into the inferior horn of the ventricle. Although the chorioid plexus has all the appearance of lying free within the ventricle, it is invested by an epithelial layer of ependyma, which excludes it from the cavity and is continuous on the one hand with the ependyma on the sharp margin of the fornix, and on the other with the ependyma of the upper surface of the thalamus.

Cornu Posterius Ventriculi Lateralis.—The posterior horn is a diverticulum which runs, from the posterior end of the central part of the ventricle, into the occipital lobe. It tapers to a point and describes a gentle curve, the convexity of which is directed laterally. The *roof* and the *lateral wall* of the posterior horn are formed by the tapetum of the corpus callosum (see p. 426).

Upon the *medial wall* two elongated, curved elevations may be seen. The upper of the two is termed the *bulb of the cornu*, and is produced by the fibres of the forceps major as they curve, backwards, from the lower part of the splenium of the corpus callosum into the occipital lobe. The lower elevation is known as the *calcar avis*. It varies greatly in size, in different brains, and is caused by an infolding of the ventricular wall which corresponds with the anterior part of the calcarine fissure.

Dissection.—If the opercula have not already been removed to expose the insula, the dissector should now insinuate his fingers underneath the fronto-parietal operculum of the insula on the right side and tear that portion of the cortex away in an upward direction. The frontal operculum (pars triangularis) and the orbital operculum should be dealt with in the same manner. The greater part of the temporal operculum has already been removed in opening up the inferior horn of the ventricle; therefore the insula is now fully exposed to view, and its relation to the parts in the interior of the ventricle can be seen.

Cornu Inferius Ventriculi Lateralis (O.T. **Descending Cornu**).—The inferior horn must be regarded as the direct continuation of the main ventricular cavity into the temporal lobe. The posterior horn is merely a diverticulum from the main cavity. At first directed backwards and laterally, the inferior horn suddenly sinks downwards, posterior to the thalamus, into the temporal lobe, in which it takes a curved course, forwards and medially, to a point about 25 mm. (*one inch*) posterior to the extremity of the temporal pole. In the angle between the diverging inferior and posterior horns the cavity of the ventricle exhibits a triangular expansion of varying capacity. It is called the *trigonum collaterale*.

The *lateral wall* of the inferior horn is formed, for the most part, by the tapetum of the corpus callosum. At the extremity of the horn the *roof* presents a slight bulging into the ventricular cavity. The bulging is called the *amygdaloid tubercle*, and it is produced by a superjacent collection of grey matter, termed the *amygdaloid nucleus*. The *stria terminalis* and the greatly attenuated *tail of the caudate nucleus* are both prolonged into the inferior horn, and are carried forwards, in its roof, to the amygdaloid nucleus.

On the *floor* of the inferior horn the dissector will note the following parts: (1) the hippocampus; (2) the chorioid plexus; (3) the fimbria; and (4) the eminentia collateralis.

Hippocampus (O.T. **Hippocampus Major**). — The hippocampus is overlapped by the chorioid plexus, which must be turned aside. It is a prominent elevation in the floor of the inferior horn of the lateral ventricle, and is strongly curved in conformity with the course taken by the horn in which it lies. It presents, therefore, a concave medial margin and a convex lateral margin. Narrow posteriorly, it enlarges as it is traced forwards, and it ends, below the amygdaloid tubercle,

FIG. 170.—Frontal Section to show relations of Inferior Cornu of Lateral Ventricle. (Part of Fig. 188 enlarged.)

in a thickened extremity, the *pes hippocampi*. The surface of the pes hippocampi is marked by some faint grooves which intervene between a number of ridges called the *hippocampal digitations*. The hippocampal elevation is due to masses of nerve cells and the nerve fibres associated with them.

Alveus.—The alveus is a thin white layer formed by nerve fibres which arise from the cells of the hippocampus, and spread out over its ventricular surface.

Fimbria (Hippocampi).—The fimbria is a narrow but very distinct band of white matter which is attached by its lateral margin along the concave medial border of the hippocampus, immediately above the fascia dentata. The white matter composing it is continuous with the thin white layer (alveus) which is spread over the surface of the hippocampus. The fimbria has two free surfaces—*superior* and *inferior*; a sharp, free *medial border*, which lies immediately above the fascia dentata, and below the chorioidal fissure; and a *lateral border*, attached to the hippocampus at its junction with the fascia dentata. It consists of the white fibres of the alveus, which assume a longitudinal direction at the margin of union of the hippocampus and the fascia dentata, and ascend to become the

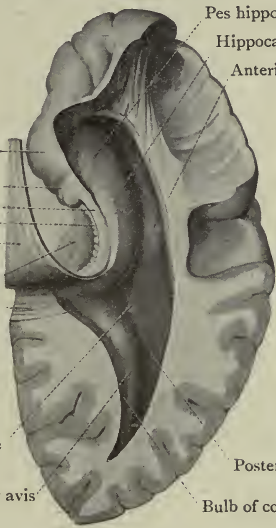


FIG. 171.—Dissection to show the Posterior and Inferior Cornua of the Lateral Ventricle.

corresponding crus of the fornix (see p. 442). It lies between the chorioid fissure and the fascia dentata (Fig. 171). Anteriorly, it runs into the recurved extremity of the uncus; and postero-superiorly, as already stated, it becomes continuous with crus of the fornix.

Chorioid Fissure of the Cerebrum.—When the pia mater in the region of the hippocampal gyrus and the fascia dentata is removed from the surface of the brain, the chorioid plexus in the interior of the inferior horn of the lateral ventricle is sometimes withdrawn with it, and a fissure then appears between the fimbria and the roof of the ventricular horn. That fissure is part of the *chorioid fissure of the cerebrum*; and it is the lateral part of the *great transverse fissure.* By the withdrawal of the chorioid plexus it is converted into an artificial gap, which

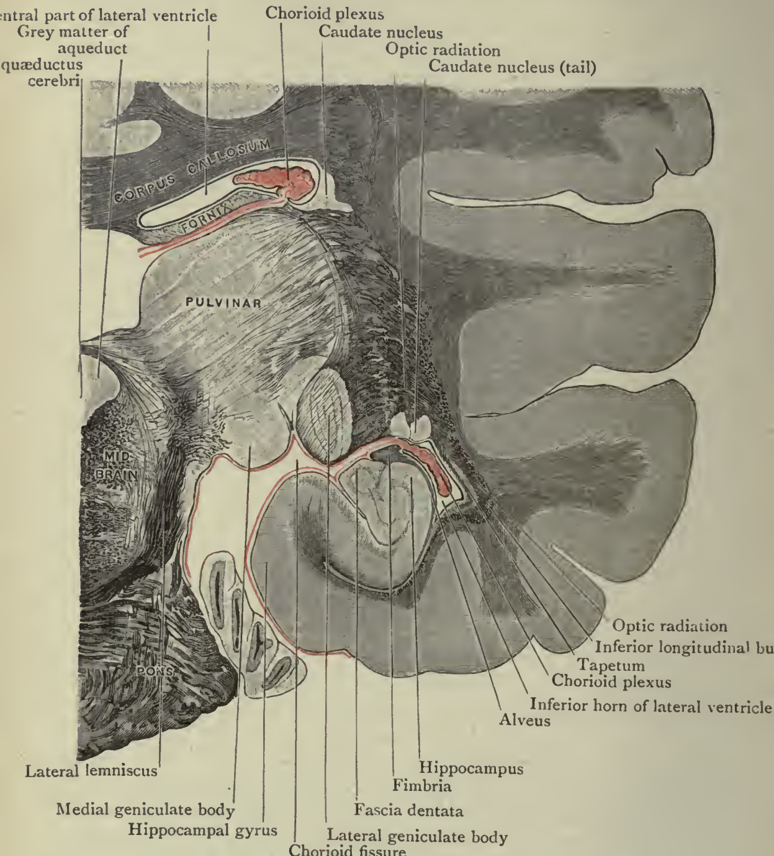


FIG. 172.—Frontal section through the Cerebrum, Mid-brain, and Pons in the plane of the geniculate bodies. It shows the relation of the chorioid fissure to the inferior horn of the lateral ventricle.

leads directly from the exterior of the brain into the interior of the inferior horn of the lateral ventricle.

Plexus Chorioideus.—The chorioid plexus is a system of convoluted blood vessels, enclosed within a fold of pia mater, which is prolonged, into the inferior horn and the central part of the lateral ventricle, through the chorioid fissure of the cerebrum. In the inferior horn it lies on the surface of the hippocampus and, at the posterior extremity of the thalamus, it becomes continuous with the chorioid plexus in the central part of the lateral ventricle (Fig. 166). But it must not be supposed that the chorioid plexus lies free in the ventricular cavity. It is clothed in the most intimate manner by an epithelial ependymal layer, which represents part of the original medial surface of the hemisphere pushed into the cavity by the chorioid plexus. The ventricle, therefore, opens on the surface through the chorioid fissure only after the thin epithelial layer is torn away by the withdrawal of the chorioid plexus.

Eminentia Collateralis.—The collateral eminence is sometimes separated into two parts, which may be distinguished from each other as the eminentia collateralis posterior and the eminentia collateralis anterior (Figs. 166, 171).

The *posterior collateral eminence* is a smooth elevation in the floor of the trigonum collaterale, in the interval between the calcar avis and the hippocampus as they diverge from one another. The *anterior collateral eminence* is not always present. It forms an elongated elevation in the floor of the inferior horn of the lateral ventricle, to the lateral side of the hippocampus. Both eminences correspond to the collateral fissure on the inferior aspect of the cerebral hemisphere.

Dissection.—The dissector should now detach the remains of the right temporal lobe and of the right occipital lobe from the rest of the cerebrum by cutting through the forceps major of the splenium of the corpus callosum and through the fimbria where it passes into the crus of the fornix. The knife should then be carried forwards from the anterior extremity of the inferior horn, above the level of the uncus, through the temporal pole. The temporal lobe, including the hippocampal gyrus along its medial side, can then be separated from the remainder of the brain, along the line of the chorioid fissure of the cerebrum. In the detached part of the cerebrum (Fig. 171) a good view is obtained of the floor of the inferior horn and of the parts in relation to it. Further, by replacing it in position, the dissector will be better able to understand the chorioid fissure, and by turning the brain upside down he will obtain a view of the roof of the inferior horn and the structures in relation to it. In that way the tail of the caudate nucleus and the stria terminalis can be traced into the amygdaloid nucleus.

The cut edge of the central part of the corpus callosum, which is still in position, should now be still further pared away, so as to bring the subjacent septum pellucidum and the fornix more fully into view.

Upon the portion of the temporal lobe which has been separated, the dissector should examine again the *fascia dentata*, which was mentioned on p. 414, and which is now much more accessible.

Fascia Dentata Hippocampi.—The fascia dentata is the free edge of grey matter which is placed between the fimbria and the deep part of the upper surface of the hippocampal gyrus. The groove between it and the fimbria is termed the *fimbrio-dentate sulcus*. The margin of the fascia is notched, and its surface is scored with numerous closely-placed vertical grooves. It begins posteriorly, in the region of the splenium of the corpus callosum, as the fasciola cinerea (Fig. 173), and it runs forwards into the cleft of the uncus, from which it emerges again in the form of a delicate band, called the *cauda fasciæ dentatæ*, which crosses the recurved part of the uncus in a transverse direction. The cauda is not always easily seen.

Septum Pellucidum—Fornix—Tela Chorioidea Ventriculi Tertii.

Septum Pellucidum.—The septum pellucidum is a thin vertical partition which intervenes between the anterior cornua and the anterior parts of the central portions of the two lateral ventricles (Fig. 164). It occupies the triangular interval between the corpus callosum and the body and columns of the fornix, being attached, above and anteriorly, to the corpus callosum, and below and posteriorly, to the fornix. It consists of two thin laminæ which form the side walls of a median cleft called the *cavum septi pellucidi* (Figs. 164, 174).

Dissection.—The narrow median strip of the corpus callosum, posterior to the genu, should now be removed. Cut it transversely across, and, gently raising it, separate the upper edge of the septum pellucidum from its lower surface. Posterior to the septum pellucidum the under surface of the median part of the corpus callosum will be found to lie upon and to be connected with the upper surface of the fornix. Sever that connection also. The left half of the forceps major should be preserved, so that its connection with the occipital lobe may be more fully made out later. Snip off the upper edge of the septum pellucidum with the scissors, in order to demonstrate the two laminæ with the interposed cleft.

Cavum Septi Pellucidi (O.T. **Fifth Ventricle**).—The cavity of the septum pellucidum is the name applied to the median cleft between the two laminæ of the septum. It varies greatly in extent, in different brains, and it contains a little fluid. It is completely isolated, having no communication either with the ventricles or with the exterior.

Fornix.—The fornix is an arched structure, composed of longitudinal and transverse fibres. It consists of a central part or body, which ends in two columns anteriorly and two crura posteriorly.

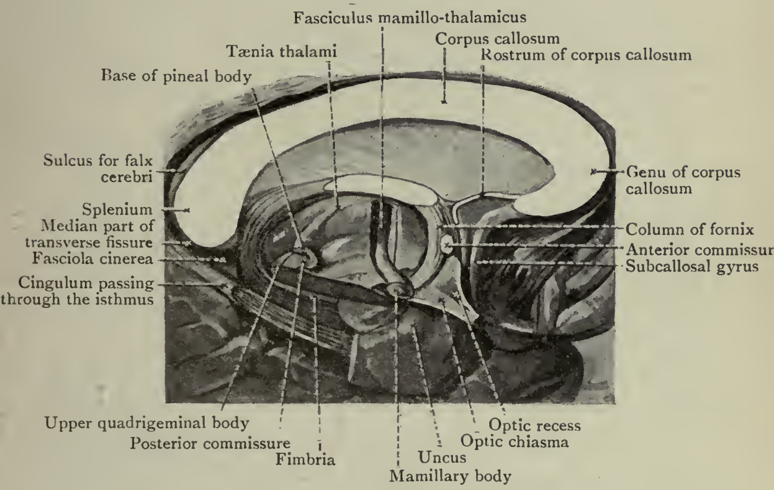


FIG. 173.—Dissection showing the relations of the Fornix.

Corpus Fornicis.—The body of the fornix is triangular in shape. Anteriorly, where it is continuous with the columns, it is narrow; posteriorly it broadens out, becomes flattened, and is prolonged into the crura (Fig. 166). The posterior part of the upper surface of the body of the fornix is in contact with and is adherent to the inferior surface of the posterior part of the body of the corpus callosum. The remaining part of the upper surface of the median portion of the fornix is attached to the posterior part of the lower edge of the septum pellucidum. Lateral to those attachments the upper surface of the body of the fornix forms a part of the floor of the lateral ventricle, on each side, and is clothed with ependyma. Each lateral margin is a sharp edge, from under which the chorioid plexus projects into the cavity of the corresponding lateral ventricle. The lower surface of the body of the fornix rests upon the tela chorioidea of the third ventricle (O.T. velum interpositum), a fold of pia mater which separates it from the third ventricle and the two thalami (Figs. 168, 187).

Columnæ Fornicis (O.T. *Anterior Pillars*). — The two columns of the fornix are two rounded strands which emerge from the anterior end of the body of the fornix, and then, diverging slightly, pass downwards, anterior to the interventricular foramina. They then sink into the grey matter on the side walls of the third ventricle, and end at the base of the brain in the corpora mamillaria (Figs. 160, 173).

Each mamillary body has the appearance of being a twisted loop of the corresponding column of the fornix, in which the fibres turn upon themselves, and are then continued upwards and backwards into the anterior tubercle of the thalamus. The appearance, however, is deceptive. In the interior of the corpus mamillare there is a nucleus of grey matter. In that nucleus the fibres of the column end; while the other fibres, which seem to be continuous with the fornix fibres, take origin within the nucleus. The strand, thus formed, is called the fasciculus mamillo-thalamicus (O.T. bundle of Vicq d'Azyr) (Fig. 173).

The connections which have just been described cannot be made out at present, but at a later period the dissector will experience little difficulty in tracing a column of the fornix to the corresponding corpus mamillare, and in displaying the connection of corpus mamillare with the fasciculus mamillo-thalamicus.

Crura Fornicis (O.T. *Posterior Pillars*).—The crura of the fornix are flattened bands which diverge from the posterior part of the body of the fornix. At first they are adherent to the under surface of the corpus callosum, but soon they sweep downwards, round the posterior ends of the thalami, and enter the inferior horns of the lateral ventricles. There each crus comes into relation with the corresponding hippocampus, and some of its fibres spread out on the surface of that prominence, where they form the *alveus*, whilst the remainder constitute the fimbria, which has been described already (p. 436, Fig. 171).

The transverse fibres of the fornix cross the lower surface of the body and the anterior part of the interval between the diverging crura. In the latter place they may be adherent to the lower surface of the corpus callosum. On each side they are continuous with the longitudinal fibres of the crura and so are prolonged, in the inferior horn, into the fimbria and the alveus. They constitute a transverse commissure from one hippocampus to the other.

Dissection.—**The body of the fornix should now be divided transversely, across its middle. Its posterior and anterior portions may then be raised from the tela chorioidea of the third ventricle, and thrown apart from each other. Had it been possible to raise the corpus callosum and fornix together, the**

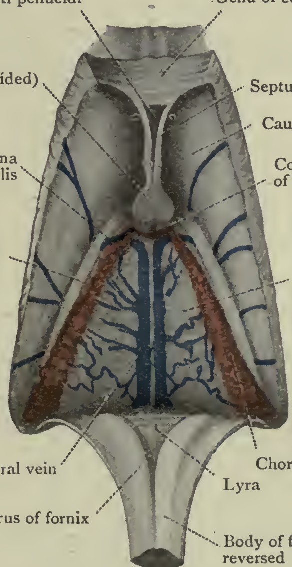


FIG. 174.—Dissection to show the Tela Chorioidea of the Third Ventricle and the parts in its vicinity. The fornix has been divided and thrown backwards.

diverging crura of the fornix would have been seen to limit a triangular space on the under surface of the corpus callosum, anterior to the posterior margin of the splenium. That interval is termed the *lyra* ; it is traversed by a series of oblique markings which indicate the presence of the transverse fibres passing across from one crus of the fornix to the other.

Tela Chorioidea Ventriculi Tertii (O.T. **Velum Interpositum**).—The tela chorioidea of the third ventricle consists of two layers of pia mater which form a fold of triangular outline. It intervenes between the body of the fornix, above, and the roof of the third ventricle and the two thalami, below. Between the two layers are blood vessels and some subarachnoideal trabecular tissue. The narrow, anterior end of the triangular fold lies between the interventricular foramina. The base is situated under the splenium of the corpus callosum, and there the upper of the two layers of pia mater which form the tela becomes continuous with the pia mater on the corpus callosum, and the lower layer becomes continuous with the pia mater on the lamina quadrigemina (Fig. 141).

In each of the two margins of the tela lies the chorioid plexus of the central part of the corresponding lateral ventricle. The plexus projects into the ventricular cavity from under cover of the free edge of the fornix. Posteriorly, it is continuous with the part of the chorioid plexus which lies in the inferior horn of the ventricle; whilst anteriorly, it narrows greatly, and becomes continuous, across the median plane, with the corresponding plexus of the opposite side. From the median junction two much smaller chorioid plexuses run, backwards, in the lower surface of the tela, and project downwards into the third ventricle. These are the *chorioid plexuses of the third ventricle* (Fig. 175).

The most conspicuous blood vessels in the tela chorioidea of the third ventricle are the two *internal cerebral veins* (O.T. *veins of Galen*), which run backwards—one on each side of the median plane. Each internal cerebral vein is formed, at the apex of the fold, by the union of the vena terminalis with a large vein issuing from the chorioid plexus; posteriorly, they unite to form the *great cerebral vein* (O.T. *vena magna Galeni*), and that vein pours its blood into the anterior end of the straight sinus (Fig. 35).

Fissura Transversa Cerebri.—The name *transverse fissure* is given to the continuous cleft through which the tela chorioidea of the third ventricle and the chorioid plexuses of the inferior horns of the lateral ventricles are introduced into the interior of the brain. It consists of an upper or middle part and two lateral parts. The middle part lies between the splenium of the corpus callosum and the body of the fornix, above, and the mid-brain, below. The base of the tela chorioidea of the third ventricle lies in it, and the blood vessels which enter and leave the tela pass through it, between the layers of the tela.

The lateral parts of the transverse fissure are the inferior parts of the *chorioidal fissures*, which have been studied already in connection with the inferior horn of the lateral ventricle (p. 437).

Dissection.—Each vena terminalis should now be divided as it unites with the internal cerebral vein. The apex of the tela chorioidea should then be seized with the forceps and pulled backwards, till the whole structure is reversed. As that is done, care must be taken to avoid injury to the attachments of the pineal body, which is enclosed in a fold of the posterior part of the lower layer of the tela. When the tela chorioidea has been displaced backwards to the level of the mid-brain, the entire upper surface of the thalamus on each side is exposed, and, between the thalami, the cavity of the third ventricle is seen. The epithelial roof of that ventricle, which is invaginated into the cavity by the chorioid plexuses of the third ventricle on the under surface of the tela, is torn away with the tela.

The Thalami and the Third Ventricle.

Thalamus.—The thalamus is a large mass of grey matter which lies obliquely across the path of the corresponding

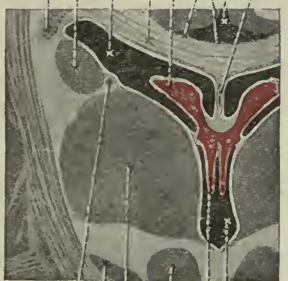


Fig. 175.—Frontal section showing immediate relations of Lateral and Third Ventricles. (Part of Fig. 188 enlarged.)

pedunculus cerebri as it ascends into the hemisphere. In their anterior two-thirds, the two thalami lie close together, but are separated by a deep median cleft called the third ventricle; the posterior thirds are further apart from one another, and the corpora quadrigemina of the mid-brain lie between them, on a lower plane. Each thalamus presents a small anterior extremity and a large posterior extremity, and four surfaces. The inferior and lateral surfaces are in apposition with, and, indeed, directly connected with adjacent parts. The superior and medial surfaces are free.

The *lateral surface* of each thalamus is applied to a mass

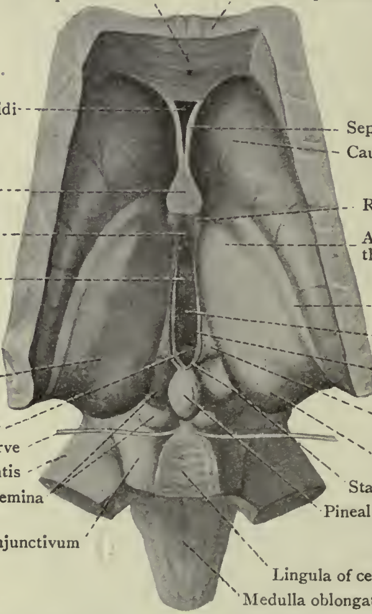


FIG. 176.—The two Thalami and the Third Ventricle as seen from above.

of white matter, termed the *internal capsule*, which is composed largely of fibres from the *basis pedunculi* of the mid-brain (Fig. 188). The *inferior* or *ventral surface* of the thalamus rests chiefly upon the *subthalamic region*, which is the prolongation upwards of the tegmental part of the pedunculus cerebri. The relation, therefore, which the thalamus presents to the upward continuation of the pedunculus cerebri is very intimate.

The *superior surface* of the thalamus is free. On the lateral side it is bounded by the groove which intervenes between the thalamus and the caudate nucleus and contains the vena terminalis and the stria terminalis. On the medial side, the superior surface of the thalamus is separated from the medial surface, in its anterior half, by a sharp edge, or prominent ledge, of the ependyma of the third ventricle. The ledge is called the *tænia thalami.* It is produced by a longitudinal strand of fibres, called the *stria medullaris*, which lies beneath the ependyma. A short distance anterior to the pineal body the tænia lies upon the upper border of a raised white band, called the *habenula*, which is directly continuous with the stria medullaris.

The habenula divides posteriorly into two parts, one of which becomes associated with the cells of the grey matter of the trigonum habenulæ of the same side (*see below*); the fibres of the other part pass through the roof of the third ventricle immediately in front of the upper part of the stalk of the pineal body. They go to the trigonum habenulæ of the opposite side and, together with their fellows of the opposite side, they form the *habenular commissure* (Fig. 177).

Between the habenula medially and the upper quadrigeminal body posteriorly, lies a small triangular depressed area, the *trigonum habenulæ.*

The superior surface of the thalamus is slightly convex, and is of a whitish colour owing to the presence of a thin superficial coating of nerve fibres (stratum zonale). It is divided into two areas by a faint oblique groove which begins near the anterior extremity of the thalamus, and extends obliquely, laterally and backwards. The sulcus corresponds to the free edge of the fornix. The two areas thus mapped out are very differently related to the ventricles of the brain. The *lateral area* includes the anterior extremity of the thalamus, and forms a part of the floor of the lateral ventricle; it is covered with ependyma, and overlapped by the chorioid plexus. The *medial area* intervenes between the lateral and third ventricles of the brain, and takes no part in the formation of the walls of either. It is covered with the tela chorioidea, above which is the fornix. It includes the posterior extremity of the thalamus.

The *anterior extremity* of the thalamus, called the *anterior tubercle*, is rounded and prominent. It projects into the lateral ventricle, lies postero-lateral to the corresponding column of the fornix, and forms the posterior boundary of the interventricular foramen.

The *posterior extremity* of the thalamus is very prominent, and it projects backwards over the mesencephalon (Fig. 176).

The most projecting part is called the *pulvinar*. But the posterior end of the thalamus shows another prominence, which is situated below and to the lateral side of the pulvinar. It is oval in form, and receives the name of the *corpus geniculatum laterale.*

The anterior two-thirds of the *medial surfaces* of the two thalami are placed very close together, and are covered not only with the lining ependyma of the third ventricle, but also with a moderately thick layer of grey matter continuous with the grey matter which surrounds the aquæductus cerebri (Sylvius). A band of grey matter, termed the *massa intermedia*, crosses the third ventricle and joins the two thalami together.

Corpus Pineale.—The pineal body is a small body of a darkish colour, and about the size of a cherry-stone, which is placed on the dorsal aspect of the mesencephalon between the posterior extremities of the two thalami (Figs. 176, 179). It occupies the depression between the two superior colliculi of the quadrigeminal lamina, and is shaped like a fir-cone. Its base, which is directed forwards, is attached by means of a hollow stalk or peduncle. The stalk is separated into a dorsal and a ventral part by a continuation into it of a pointed recess of the cavity of the third ventricle. The dorsal part of the stalk becomes continuous, on each thalamus, with the tænia thalami, and through it pass the fibres of the habenular commissure; the ventral part is folded round a narrow but conspicuous cord-like band of white fibres (*posterior commissure*) which crosses the median plane immediately below the base of the pineal body.

Commissura Anterior Cerebri.—In the anterior part of the cleft between the two thalami, and immediately anterior to the columns of the fornix, a round bundle of white fibres will be seen crossing the median plane (Figs. 177, 173). It is the *anterior commissure.* It is very much larger than the posterior commissure, and will be afterwards followed towards the temporal lobe, in which the greater part of it ends.

Ventriculus Tertius.—The third ventricle is the name given to the deep, narrow cleft between the two thalami. It is deeper anteriorly than posteriorly, and extends from the pineal body posteriorly to the anterior commissure and lamina terminalis anteriorly. Its *floor* is formed by the parts already studied within the interpeduncular fossa on the base of the brain, viz., the tuber cinereum, the corpora mamillaria, and the grey matter of the substantia perforata posterior, and also, more posteriorly, by the tegmenta of the cerebral peduncles. *Anteriorly*, it is bounded by the lamina terminalis, the anterior commissure, and the columns of the fornix. At the angle of junction of the anterior boundary and the floor lies the optic

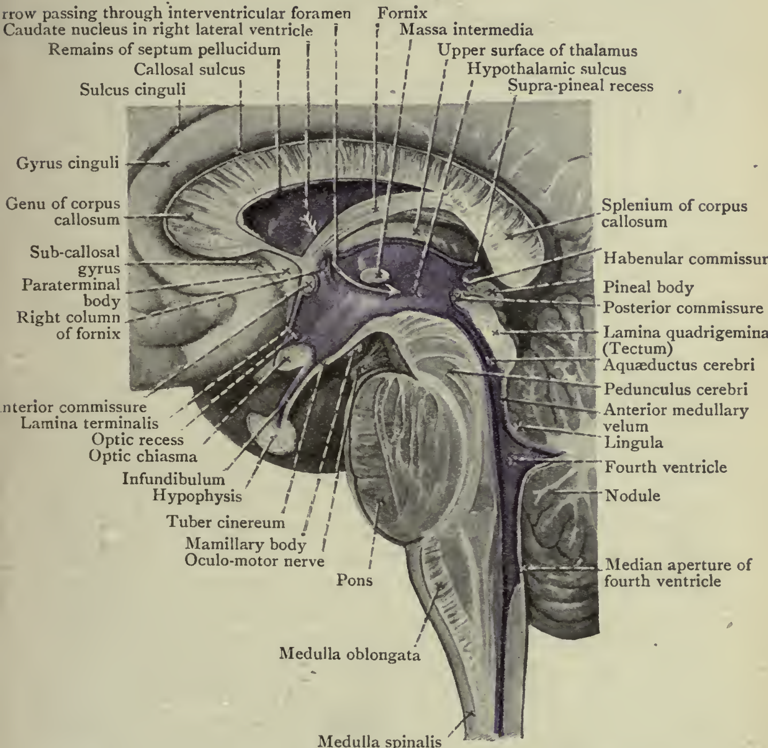


FIG. 177.—Sagittal section of Corpus Callosum, Fornix, Diencephalon, Mid-brain, and Hind-brain. The septum pellucidum has been removed to expose the cavity of the right lateral ventricle, from which an arrow passes through the interventricular foramen to the third ventricle.

chiasma. Each *side wall* is formed by the medial surfaces of the corresponding thalamic and hypothalamic parts of the diencephalon. A little anterior to the middle of the ventricle the cavity is crossed by the *massa intermedia*, which connects the thalami with each other, and anterior to that the column of the fornix will be seen, descending in the side wall. At the anterior end of the side wall lies the interventricular foramen which is bounded in front by the corresponding column of the fornix. At the lower margin of the interventricular foramen the column of the fornix turns laterally and disappears in the anterior part of the hypothalamus to reach the mamillary body.

The *roof* of the third ventricle is formed by a thin epithelial layer which stretches across the median plane, from the one tænia thalami to the other. It is applied to the under surface of the tela chorioidea, which overlies the ventricle, and is invaginated into the cavity by the chorioid plexuses which hang down from the under surface of that fold of pia mater. In the removal of the tela chorioidea the thin epithelial roof was torn away (Figs. 175, 187).

The third ventricle communicates with the lateral ventricles, through the *interventricular foramina*, and it communicates with the fourth ventricle by the *aquæductus cerebri* (*Sylvius*), a narrow channel which tunnels the mesencephalon. The opening of this canal will be seen in the posterior wall of the third ventricle, immediately below the posterior commissure. The *interventricular foramina*, which put the third into communication with the two lateral ventricles, lie at the anterior part of the third ventricle, one on each side. Each passes laterally and slightly upwards, between the most prominent part of the corresponding column of the fornix and the anterior tubercle of the thalamus. Through the foramina the epithelial lining of the third ventricle becomes continuous with that of the lateral ventricles (Figs. 177, 165, 166).

From each interventricular foramen a distinct groove passes backwards, on the side wall of the ventricle, to the mouth of the aquæductus cerebri. It is termed the *sulcus hypothalamicus*, and it separates the ventral part of the boundary of the third ventricle, which is called the hypothalamus, from the more dorsally placed thalamus.

The outline of the third ventricle is seen to be very irregular when it is viewed from the side in a median section through the brain (Fig. 177), or as it is exhibited in a plaster cast of the ventricular system of the brain (Fig. 165). It presents several diverticula or recesses. Thus, in the anterior part of the floor there is a deep funnel-shaped recess, *recessus infundibuli*, leading down, through the tuber cinereum, into the infundibulum of the hypophysis. Another recess, *recessus opticus*, lies above the optic chiasma. Posteriorly, two additional recesses are present. One, the *recessus pinealis*, passes backwards, above the posterior commissure and the entrance of the aquæductus cerebri, into the stalk of the pineal body. The second is placed still higher, and is carried backwards for a greater distance. Its walls are epithelial, and therefore it cannot be seen in an ordinary dissection. It is termed the *recessus suprapinealis* (Fig. 177).

Dissection.—The further study of the cerebral hemispheres should be postponed until the examination of the mid-brain or mesencephalon is completed. The membranes should be removed from the upper surface of the cerebellum, and the prominent anterior part of that organ may then be pulled backwards to expose, as far as possible, the corpora quadrigemina, *i.e.* the four rounded eminences or colliculi on the dorsal aspect of the mesencephalon. As the cerebellum is displaced backwards, care should be taken to secure and preserve the slender trochlear nerves. They wind round the lateral sides of the pedunculi cerebri, after they have issued from a lamina, called the anterior medullary velum, which lies immediately below the inferior pair of colliculi.

THE MESENCEPHALON.

The mesencephalon or mid-brain is the stalk which occupies the aperture of the tentorium cerebelli, and connects the cerebral hemispheres with the parts in the posterior cranial fossa.[1] It is about three-quarters of an inch long, and it consists of a dorsal part, the *lamina quadrigemina*, and a much larger ventral part, which is formed by the two large *pedunculi cerebri*. In the undissected brain the lamina quadrigemina is completely hidden from view by the splenium of the corpus callosum, which projects backwards over it, and also by the superimposed cerebral hemispheres. The pedunculi cerebri, however, can be seen, to some extent, at the base of the brain, where they bound the posterior part of the interpeduncular fossa. The mesencephalon is tunnelled from end to end by a narrow passage called the *aquæductus cerebri* (Sylvius). The aqueduct lies much nearer the dorsal than the ventral surface of the mid-brain, and it connects the third ventricle with the fourth ventricle.

Lamina Quadrigemina.—The dorsal surface of the lamina quadrigemina is raised into four eminences or *colliculi*, two superior and two inferior, which are called the *corpora quadrigemina*. Each colliculus is composed, for the most part,

[1] If the mesencephalon was divided, when the brain was removed, the divided parts must be fixed together with pins while the superficial characters are being studied.

of grey matter, but each has also a superficial coating of white fibres. The *superior colliculi* are larger and broader than the *inferior*, but they are not so well defined nor yet so prominent.

A longitudinal and a transverse groove separate the quadrigeminal bodies from one another. The *longitudinal groove* occupies the median plane, and extends upwards as far as the posterior commissure. From its lower end a short but well-defined narrow band of white fibres, called the *frenulum veli*, passes to the anterior medullary velum, a lamina which lies immediately below the inferior pair of quadrigeminal prominences, in the roof of the fourth ventricle. The upper part of the longitudinal groove is occupied by the pineal body. The *transverse groove* curves round below each of the two superior colliculi and separates them from the inferior pair.

Brachia of the Corpora Quadrigemina.—The corpora quadrigemina form the dorsal part of the mid-brain, but each body is connected also with the corresponding lateral aspect of the mesencephalon by a prominent white strand, which is prolonged upwards and forwards under the projecting pulvinar. The strands are called the *brachia* of the corpora quadrigemina, and they are separated from each other by a continuation, on the side of the mesencephalon, of the transverse groove which separates the superior colliculi from the inferior.

Corpus Geniculatum Mediale.—Closely connected with the brachium of the inferior quadrigeminate body will be seen the medial geniculate body. It is a little oval eminence, very sharply defined, which lies on the side of the upper part of the mesencephalon under shelter of the pulvinar of the thalamus.

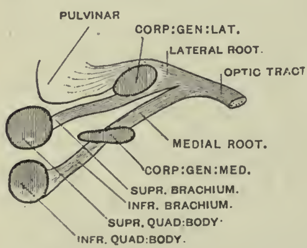


FIG. 178.—Diagram of the Roots of the Optic Tract.

Connections of the Brachia and the Termination of the Optic Tract.—There are two superior and two inferior brachia, right and left, connected respectively with the corresponding superior and inferior colliculi, and two optic tracts, right and left, which pass backwards from the optic chiasma at the base of the brain.

Each *inferior brachium* runs upwards and forwards from the corresponding inferior colliculus and disappears from view, under cover of the medial geniculate body. Many of the fibres of which it is composed pass upwards towards the higher parts of the brain in the tegmental portion of the corresponding pedunculus cerebri, but some terminate amidst the cells of the medial geniculate body.

Each *superior brachium* passes from the side of the corresponding superior colliculus upwards, forwards, and laterally between the medial geniculate body and the pulvinar. A superficial examination of it is sufficient to show that it is connected with the lateral root of the optic tract of the same side by fibres which pass through the interval between the two geniculate bodies; and with the corresponding lateral geniculate body. It is important to remember, however, that the fibres of which it is formed are connected with other regions in addition to those indicated by superficial appearances. By means of the fibres which it receives from the optic tract it connects the superior colliculus with the retinæ of both sides. Other fibres of the superior brachium connect the superior colliculus with the lateral geniculate body; and a third series of fibres passes through the superior brachium on its way from the visual region of the occipital part of the cortex to the superior colliculus.

Tractus Optici.—The optic tracts are two relatively broad white strands, right and left, which issue from the corresponding postero-lateral angles of the optic chiasma. Each tract consists of fibres derived from the corresponding parts of the retinæ of the two sides and of fibres which connect the inferior colliculus of one side with the medial geniculate body of the opposite side. After it issues from the chiasma the tract runs backwards, first round the side of the tuber cinereum and then round the lateral side of the pedunculus cerebri, and, whilst at the side of the pedunculus cerebri, it is in relation, laterally, with the hippocampal gyrus of the cerebrum. When the tract reaches the dorsal part of the lateral aspect of the pedunculus it divides into two portions, which are called its medial and lateral roots.

The *medial root* ends in the medial geniculate body and it consists largely, if not entirely, of fibres which connect the medial geniculate body of one side with the inferior colliculus of the opposite side, and which are known as Gudden's commissure.

The *lateral root* of the optic tract consists of fibres derived from the retinæ of both sides. They terminate partly in the lateral geniculate body; partly in the pulvinar; and partly in the superior colliculus of the same side, to which they pass through the superior brachium.

Pedunculi Cerebri (O.T. crura cerebri).—The cerebral peduncles constitute the chief bulk of the mesencephalon. When the brain is viewed from below, they appear as two large rope-like strands, which emerge, close together, from the upper aspect of the pons, and diverge as they proceed upwards and forwards to the cerebral hemispheres At the

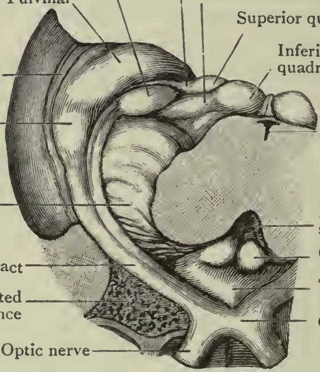


FIG. 179.—The Origin and Relations of the Optic Tract. (Professor Thane, from *Quain's Anatomy.*)

point where each peduncle disappears into the corresponding hemisphere, it is embraced, on its lateral side, by the optic tract and the gyrus hippocampi.

Each pedunculus cerebri consists of two parts, viz., a dorsal part, called the *tegmentum*, which is prolonged upwards to the region below the thalamus; and a ventral part, called the *basis* (O.T. *crusta*), which is carried upwards into a layer of white fibres called the internal capsule, situated on the lateral side of the thalamus. When the brain is examined from below the bases of the peduncles are seen. They are white in colour and streaked in the longitudinal direction. On the exterior of the mesencephalon, the separation between the two parts of the pedunculus cerebri (*i.e.* the tegmentum and the basis pedunculi) is indicated by a medial and a lateral groove or sulcus. The medial sulcus is the deeper and more distinct. It looks into the interpeduncular fossa, and from it emerge the fila of the oculo-motor nerve. It consequently receives the name of the *sulcus oculomotorius*. The lateral groove is termed the *sulcus lateralis*.

Cut Surface of the Mesencephalon. — When the cut surface of a mesencephalon, which has been divided transversely, is examined, the first point which should be noted is the position of the *aquæductus cerebri* (Figs. 180, 181). It is a narrow passage which lies nearer the dorsal surface than the ventral surface of the mesencephalon, and it leads from the fourth ventricle, below, to the third ventricle, above. It is surrounded by a thick layer of grey matter, called the *central grey matter of the aqueduct*. In a fresh brain the central grey matter is always very conspicuous, and in its midst are situated the nuclei of the oculo-motor and trochlear nerves, and the upper nucleus of the trigeminal nerve, but, except in very favourable circumstances, the positions of the nuclei cannot be detected by the naked eye. The grey matter of the aqueduct is continuous, below, with the grey matter spread out on the anterior wall of the fourth ventricle; whilst, above, it is continuous with the grey matter on the floor and sides of the third ventricle.

The division between the tegmentum and the basis pedunculi, on each side, is rendered very evident by a conspicuous lamina of dark pigmented matter, termed the *substantia nigra*, which intervenes between them.

Substantia Nigra.—As seen in transverse section, the substantia nigra presents a somewhat crescentic outline. It is a thick band interposed between the basal and tegmental parts of each pedunculus cerebri, and it consists of grey matter many of the cells of which are deeply pigmented. It begins, below, at the upper border of the pons, and it extends upwards into the subthalamic region. Its margins come to the surface at the oculo-motor and lateral sulci, and its medial part is traversed by the merging fibres of the oculo-motor nerve. The surface turned towards the tegmentum is concave and uniform; the opposite surface is convex, and is rendered highly irregular by the presence of numerous slender prolongations of its substance into the basis pedunculi.

Basis Pedunculi (O.T. **crusta**).—The basis pedunculi is somewhat crescentic when seen in section, and stands quite apart from its fellow of the opposite side. It is composed of a compact mass of longitudinally directed nerve fibres which are carried upwards into the internal capsule. The intermediate three-fifths of each basis pedunculi is formed, almost entirely, by the important *cerebro-spinal fasciculus* (O.T. *pyra-*

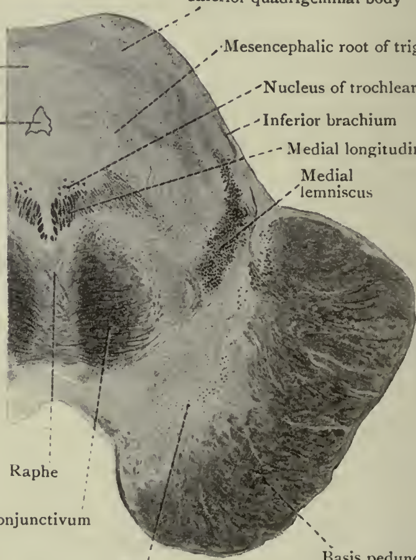


FIG. 180.—Transverse section through the Mesencephalon at the level of the inferior quadrigeminal body: the right side only is reproduced. The drawing is taken from a Weigert-Pal specimen, and therefore the grey matter is pale and the strands of white matter are dark. The dark colour of the substantia nigra is not evident owing to the thinness of the section.

midal tract) as it descends from the motor area of the cerebral cortex, but the cerebro-spinal fasciculus is quite indistinguishable, under ordinary circumstances, from the fronto-pontine fibres on its medial side and the temporo-pontine fibres on its lateral side.

Tegmentum.—Unlike the bases pedunculi, the tegmentum is undivided, a faint line in the median plane, termed the *median raphe*, alone indicating that it consists of a right and a left half. Towards the dorsum of the mesencephalon it is fused with the deep surface of the lamina quadrigemina, and only its lateral surfaces are free.

The tegmentum is composed of an admixture of grey and white matter, constituting what is termed a *formatio reticularis.* The white matter consists of fibres running both transversely and longitudinally. Certain of the longitudinal fibres are grouped together and form well-marked tracts, which, in a section through the mesencephalon of a fresh brain, can be detected by the naked eye. The tracts are: (1) the medial longitudinal bundles; (2) the brachia conjunctiva; (3) the lemnisci.

FIG. 181.—Section through upper part of Mesencephalon at level of superior quadrigeminal body. The drawing is taken from a Weigert-Pal specimen. The dark colour of the substantia nigra is not evident owing to the thinness of the section.

Fasciculus Longitudinalis Medialis.—The medial longitudinal fasciculus (Figs. 180 and 181) is a small, compact bundle which is placed upon the corresponding lateral aspect of the ventral portion of the central grey matter of the aqueduct.

The *brachia conjunctiva* (O.T. *superior cerebellar peduncles*) are two large strands which are continued upwards from the cerebellum into the mesencephalon. By pulling away the margin of the cerebellum, where it overlaps the inferior colliculi of the quadrigeminal lamina, the dissector will see the brachia on the surface as they converge in an upward direction.

Stretching across the interval between them, and bringing them into continuity with one another, is a thin lamina called the anterior medullary velum. When the brachia conjunctiva reach the bases of the inferior quadrigeminal bodies, they sink into the substance of the mesencephalon, and, in a transverse section through the lower part of that portion of the brain, they may be seen as two white strands, semilunar in outline and placed one on each side of the grey matter of the aqueduct. As they ascend, they gradually assume a deeper (*i.e.* a more ventral) position in the tegmental part of the mesencephalon, and they decussate with each other across the median plane and proceed upwards to the red nuclei.

The term *lemniscus* (O.T. *fillet*) is given to two tracts which have different connections. The *medial lemniscus* (Figs. 180 and 181) is a sensory tract passing upwards to the thalamus. The *lateral lemniscus* belongs to the acoustic apparatus, and is a part of a chain through which the cochlear nuclei of one side establish connection with the inferior quadrigeminal body and the medial geniculate body of the opposite side. The lateral lemniscus can be readily detected as it emerges from the upper part of the lateral sulcus of the mid-brain, and passes, backwards and upwards, to the lower border of the inferior quadrigeminate body and inferior brachium. It has the form of a raised triangular band which encircles the lateral surface of the upper end of the brachium conjunctivum (Fig. 194).

Within the upper part of the tegmentum there is a collection of nuclear matter which is termed the *nucleus ruber*, from its ruddy appearance when seen in section. It is rod-like in form, and extends upwards into the tegmental region below the thalamus (Fig. 188). In transverse section it presents a circular outline, and it is closely associated with the upward prolongations of the majority of the fibres of the brachium conjunctivum of the opposite side. The brachium conjunctivum cerebelli is an efferent tract from the nucleus dentatus of the hemisphere of the cerebellum, and its fibres end in the red nucleus and the pulvinar of the thalamus of the opposite side. The tegmentum of each pedunculus cerebri may be considered to consist of two parts: viz., a *lower part*, which is subjacent to the inferior quadrigeminal bodies, and is largely occupied by the decussation of the brachia conjunctiva cerebelli; and an *upper part*, subjacent to the superior quadrigeminal bodies, which is traversed by the emerging bundles of the third nerve, and contains the nucleus ruber.

BASAL GANGLIA OF THE CEREBRAL HEMISPHERES.

The basal ganglia of the cerebral hemispheres must now be examined. They are (1) the caudate and lentiform nuclei, which, together, form the corpus striatum, (2) the claustrum, and (3) the amygdaloid nucleus. At the same time the composition of the thalamus and the external and internal capsules should be studied.

Dissection.—The right and left portions of what remains of the cerebrum must be separated from one another, if that has not already been done, by a median sagittal incision. Anteriorly, the incision must pass between the columns of the fornix, and it will divide the anterior part of the corpus callosum, the lamina terminalis, the anterior commissure and the optic chiasma. In the interval between the columns of the fornix and the corpus callosum the knife should pass through the cavity between the layers of the septum pellucidum. Posteriorly, the incision will bisect the pineal body and its peduncle, and the upper part of the lamina quadrigemina, which is still attached to the cerebrum; then it will pass through the upper part of the aquæductus cerebri,

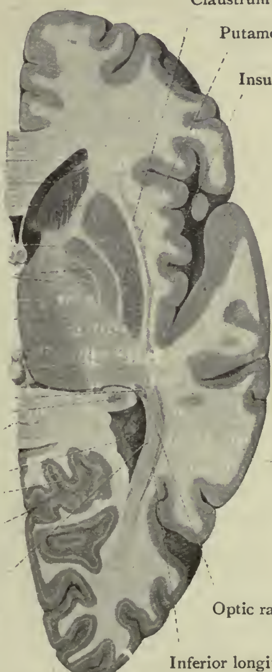


FIG. 182.—Horizontal section through the Right Cerebral Hemisphere at the level of the widest part of the lentiform nucleus.

and, ventral to the aqueduct, it will separate the cerebral peduncles of opposite sides from one another. As the knife passes through the base of the brain, that is, through the floor of the third ventricle, from before backwards, it will divide the tuber cinereum; then it will pass between the mamillary bodies, and, posteriorly, it will bisect the posterior perforated substance. The massa intermedia, which unites the adjacent surfaces of the thalami, will be divided as the knife passes through the cavity of the third ventricle. After the division has been made the dissector should note the positions and relations of the divided parts, and he should compare the cut surfaces with Figs. 177, 159.

When the study of the cut surfaces is completed, a horizontal incision must be made through the remains of the right half of the cerebrum, at the level of the upper part of the interventricular foramen, in order to display the relative positions of the basal ganglia. And through the left part of the cerebrum a number of frontal or vertical transverse incisions must be made, the first, immediately in front of the posterior end of the olfactory tract, the second, through the anterior perforated substance; the third, immediately anterior to the mamillary bodies, and the fourth, through the cerebrum and then through the front part of that portion of the cerebral peduncle which is still attached to it.

After the sections have been made, examine the horizontal section first (Figs. 182, 183), and note the following points, using the upper surface of the lower segment:—(1) The peripheral grey and the central white matter of the hemisphere. (2) Close to the median plane, from before backwards—(*a*) the divided anterior part of the corpus callosum and the fibres of the forceps minor passing forwards and laterally from it into the white matter of the frontal lobe; (*b*) the right layer of the septum pellucidum; (*c*) the divided right column of the fornix; (*d*) the medial surface of the thalamus, separated from the column of the fornix by the interventricular foramen; (*e*) medial to the posterior part of the thalamus, the upper surface of the anterior part of the lamina quadrigemina and a part of the pineal body. (3) Lateral to the anterior divided part of the corpus callosum is the cavity of the anterior horn of the lateral ventricle. (4) In the lateral wall of the floor of the anterior horn the divided head of the caudate nucleus of the corpus striatum. (5) Bounded medially by the head of the caudate nucleus and the thalamus, a broad band of the white matter called the *internal capsule.* (6) Lateral to the internal capsule, a triangular mass of grey matter called the *lentiform nucleus.* It is divided into three parts by two thin white laminæ called the medial and lateral medullary laminæ. The most lateral of the three parts is called the *putamen*; it is larger and darker than the medial two portions, which form, together, the *globus pallidus*, which is paler than the putamen. (7) Lateral to the lentiform nucleus, a thin lamina of white matter called the *external capsule.* It is continuous, anteriorly and posteriorly, round the anterior and posterior margins of the lentiform nucleus, with the anterior and posterior borders of the internal capsule, and it is bounded, laterally, by—(8) A thin lamina of grey matter called the *claustrum*, which has a smooth medial surface and a scalloped lateral surface. (9) The insula, which lies lateral to the claustrum and consists of a layer of white and a layer of grey matter. It forms the medial wall of—(10) A space called the lateral fossa of the hemisphere. The lateral fossa is

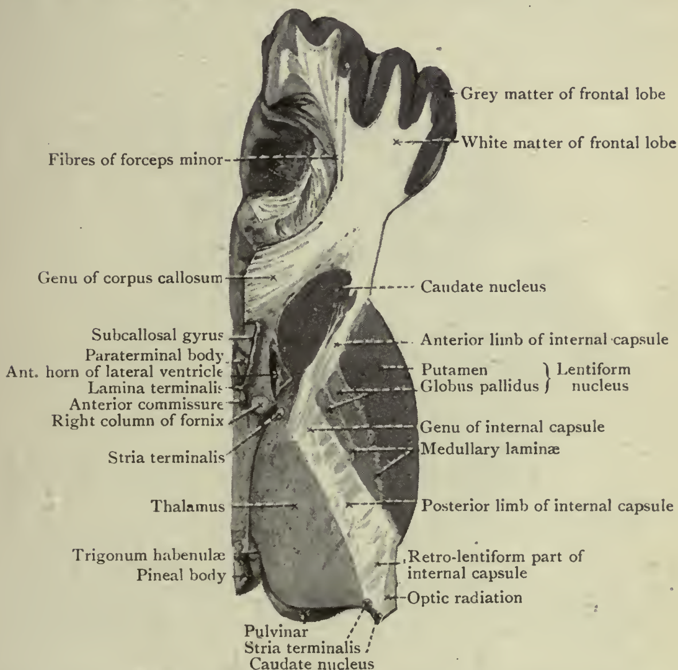


FIG. 183.—Horizontal section of Corpus Striatum and adjacent parts on the right side, after the dissection represented in Fig. 182 had been made. The line to the anterior horn of the lateral ventricle crosses the right lamina of the septum pellucidum.

bounded on the lateral side by—(11) The frontal operculum, anteriorly, and (12) the temporal operculum, posteriorly, and it opens to the exterior by—(13) The lateral fissure which passes between the two opercula. (14) At the postero-lateral angle of the thalamus, note a small grey mass (see Fig. 182); it is the tail of the caudate nucleus, descending into the roof of the inferior horn of the lateral ventricle. Place the upper segment of the divided brain on the lower segment, and trace the continuity of the caudate nucleus, along the floor of the central part of the lateral ventricle, from the divided tail, posteriorly, to the divided head, anteriorly. Then turn the lower segment of the section upside down and trace the tail of the caudate nucleus, along the roof of the inferior horn of the lateral ventricle, to the amygdaloid tubercle at the anterior end of the roof. (15) Immediately to the medial side of the divided tail of the caudate nucleus is the thin

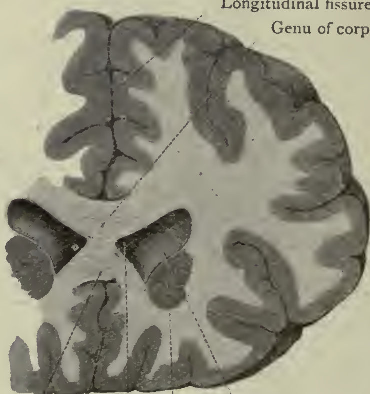


FIG. 184.—Frontal section through the Frontal Lobes of the Cerebrum. The posterior surface of the anterior part of the cerebrum is depicted so that the reader is looking into the anterior horns of the lateral ventricles from behind.

strand of white fibres, called the stria terminalis, which was noted previously in the floor of the central part of the lateral ventricle (see p. 431). Trace it also along the roof of the inferior horn to the amygdaloid tubercle.

Examine next the series of vertical transverse sections and note—(1) That, in the first section, which passes through the posterior part of the frontal lobe, the head of the caudate nucleus and the anterior part of the lentiform nucleus are fusing together, ventro-lateral to the anterior horn of the lateral ventricle (see Fig. 185). Note also that, as they blend, a striate appearance is produced by the intermingling of a large number of grey and white striæ which pass between the two grey masses. It is because of the union and because of the striate appearance in the region of the union that the caudate nucleus and the lentiform nucleus are spoken of, together, as the corpus striatum. (2) That, in the second section, which passes through the region of the anterior perforated substance (Fig. 186), the lower surface of the

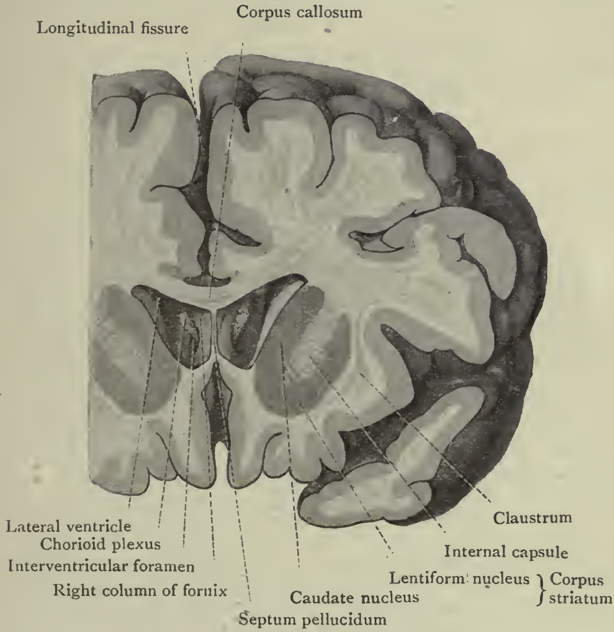


FIG. 185.—Frontal section through the Cerebral Hemisphere cutting through the anterior part of the lentiform nucleus. Seen from the anterior end.

anterior parts of the lentiform and caudate nuclei are blending with the anterior perforated substance. (3) That, in the third section, which passes between the tuber cinereum and the mamillary bodies, the main features referred to in the account of the horizontal section are again visible, but that there are some modifications due to the different plane of section (Fig. 187). The points of difference to be noted are—(*a*) That the caudate nucleus, the stria terminalis and the lateral part of the upper surface of the thalamus lie, in this section, in the floor of the central part of the lateral ventricle. (*b*) That in the substance of the thalamus two divided white bundles are seen. The lower of the two bundles is the divided column of the fornix on its way to the mamillary body; and the higher is the fasciculus mamillo-thalamicus on its way from the mamillary body to the upper and anterior part of the thalamus. (*c*) That, lateral to the thalamus is the lentiform nucleus, clearly divided in this position into three parts by the two medullary laminæ. (*d*) That, between the lentiform nucleus, laterally, and the thalamus and the caudate nucleus, medially, is the internal capsule. (*e*) That, as the internal capsule passes

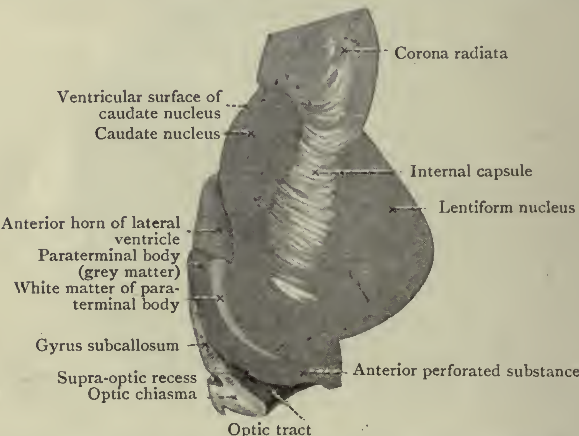


FIG. 186.—Frontal section through anterior Perforated Substance and the anterior part of Corpus Striatum, after the dissection represented in Fig. 183 had been made on the left hemisphere.

between the caudate nucleus and the upper part of the lentiform nucleus, its fibres begin to diverge towards all the adjacent parts of the cortex, forming the *corona radiata*. (*f*) That the lower end of the internal capsule is continuous with the upper and most anterior part of the pedunculus cerebri. (*g*) That, from the pedunculus cerebri fibres are passing laterally, below the lentiform nucleus, to the medullary striæ and the external capsule. (*h*) That, immediately below and lateral to the section of the pedunculus is the divided optic tract. (*i*) That, lateral to the lentiform nucleus is the external capsule, and still more laterally lie the claustrum and the insula.

Note further, that the plane of the section under consideration is anterior to the anterior end of the inferior cornu of the lateral ventricle (see Fig. 187). (4) That in the fourth section—(*a*) The fibres of the internal capsule are directly continuous, below, with the fibres of the basal or anterior part of the peduncle of the cerebrum, and, above, with the corona radiata, to which fibres converge from the adjacent parts of the grey matter of the cortex. (*b*) In the region

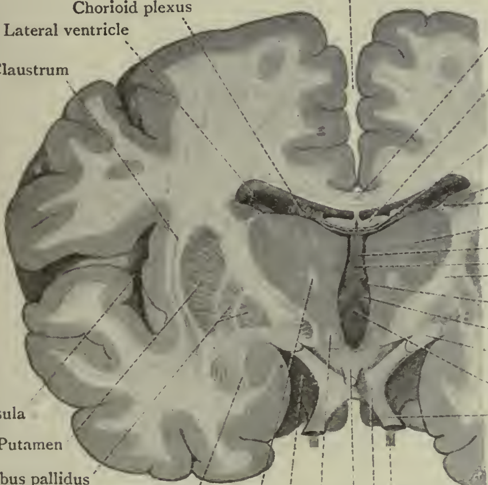


FIG. 187.—Frontal section through the Cerebral Hemisphere in such a plane as to cut the three parts of the lentiform nucleus; the posterior cut surface of the anterior part of the hemisphere is depicted.

now under consideration, the thalamus rests upon the subthalamic region which is directly continuous with the tegmental or dorsal part of the corresponding pedunculus cerebri. (*c*) In the subthalamic region two additional nodules of grey matter are easily recognisable. The medial and more rounded of the two is the upper part of the *red nucleus*, which extends downwards, through the upper half of the tegmental portion of the mid-brain. The more lateral is the *hypothalamic body*, which is limited to the posterior part of the subthalamic region. (*d*) The lentiform nucleus now lies above the roof of the inferior horn of the lateral ventricle, from which it is separated by a layer of transversely directed white fibres (Fig. 188). (*e*) The lentiform nucleus is not

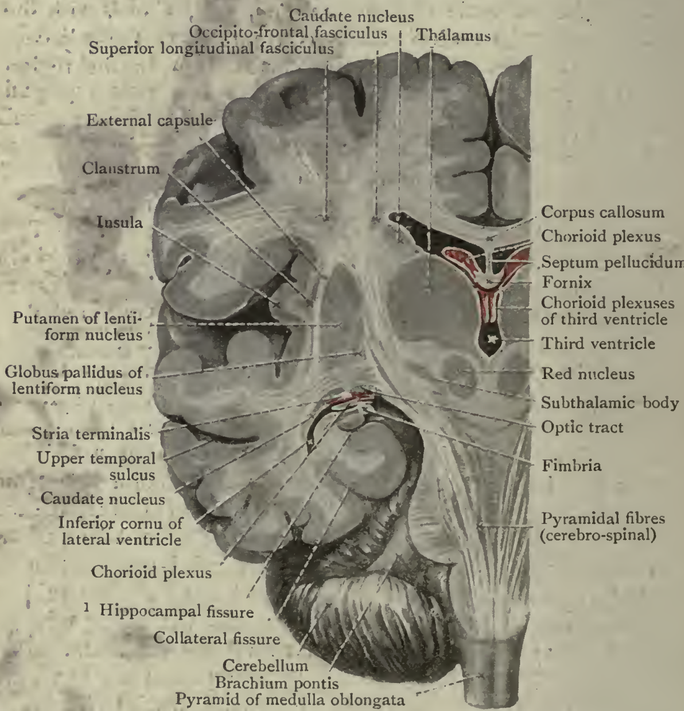


FIG. 188.—Oblique frontal section of Brain to show the course of the cerebro-spinal fibres. The internal capsule lies between the lentiform nucleus laterally and the caudate nucleus and thalamus medially.

now so distinctly divided into three segments by the medullary laminæ.

When the examination of the surface appearances of the sections is completed the dissector should study, in more detail, the parts which he has seen in various portions of their extent in the series of sections. He should replace the

[1] This fissure is an artifact (Elliot Smith).

sections in their proper relations to each other at one time, and separate them from each other again, when necessary, and so confirm the majority of the statements contained in the following accounts of the individual structures.

Corpus Striatum.—The corpus striatum is a mass of grey matter embedded in the base of the hemisphere. It consists of two parts—a supero-medial part, the caudate nucleus, and an infero-lateral part, the lentiform nucleus. The anterior portions of the two nuclei are blended together, but the remaining portions are separated from one another by a thick layer of white substance of the hemisphere, called the internal capsule.

Nucleus Caudatus.—The caudate nucleus is a comma-shaped mass. The head of the comma lies in the lateral wall of the anterior horn of the lateral ventricle. The body runs backwards, in the lateral part of the floor of the central portion of the cavity of the lateral ventricle and the tail turns downwards and forwards in the roof of the inferior horn. The lower and anterior part of the head is fused with the anterior part of the lentiform nucleus (Fig. 185). One surface of the caudate nucleus is intraventricular, that is, it is in direct relation with the cavity of the lateral ventricle and is covered with the ependyma. The opposite surface is extra-ventricular. The extraventricular surface of that part of the nucleus which lies in the anterior horn, and in the central part of the lateral ventricle, is in relation with the internal capsule, but the extraventricular surface of the portion of the tail which lies in the roof of the inferior horn of the ventricle is separated from the lower surface of the lentiform nucleus by fibres passing, more or less transversely, between the cortex of the temporal lobe and the upper part of the corresponding peduncle of the brain and the subthalamic region. The medial border of the caudate nucleus is separated from the thalamus by the stria terminalis; and the lateral border, in the region of the anterior horn and the central part of the lateral ventricle, is in relation with the medial surface of the upper part of the internal capsule, and with a bundle of longitudinal fibres of the white matter of the cerebrum called the occipito-frontal fasciculus (Fig. 188).

Nucleus Lentiformis.—The lentiform nucleus is an irregular triangular pyramid of grey matter. It possesses an inferior surface or base (Figs. 187, 188); a lateral surface;

and an antero-medial and a postero-medial surface (Figs. 182, 191).

The posterior part of the inferior surface lies above the inferior horn of the lateral ventricle, from which it is separated by some white matter and by the tail of the caudate nucleus and the stria terminalis (Fig. 188). More anteriorly the inferior surface rests upon the white matter of the temporal lobe of the hemisphere, and still more anteriorly it fuses with the grey matter of the anterior perforated substance (Fig. 186). Curving backwards and laterally in a groove on the lower surface of the lentiform nucleus lies the twisted bundle of fibres of the anterior commissure, on its way to the temporal lobe (Fig. 189).

The lateral surface is convex and is in relation, in the whole of its extent, with a layer of white matter, called the external capsule, which separates it from the claustrum.

The antero-medial and the postero-medial surfaces are in relation with the internal capsule, and the medial angle which separates the two surfaces lies in a bend of the capsule which is called the *genu* (Figs. 182, 191).

Passing vertically through the lentiform nucleus and dividing it into three parts are two white layers called the medullary laminæ. As already stated, the medial two parts are lighter in colour than the lateral part; they constitute the *globus pallidus*. The lateral part is the *putamen*.

The antero-inferior part of the lentiform nucleus is continuous with the head of the caudate nucleus and the anterior perforated substance (Fig. 186), but in the remainder of its extent the lentiform nucleus is surrounded by the white matter of the hemisphere.

The lentiform nucleus is associated with the cortex of the hemisphere, with the thalamus, and with other adjacent parts, by white nerve fibres which pass to and from the nucleus.

Claustrum.—The claustrum is a thin plate of grey matter which lies between the external capsule and the white matter of the insula. Its medial surface, which is relatively smooth, is separated from the lateral surface of the lentiform nucleus by the external capsule. Its lateral surface is scalloped, the elevations and depressions corresponding with the gyri and sulci of the insula. Its lower border, which is its broadest part, is fused, anteriorly, with the anterior perforated substance and the amygdaloid nucleus. In extent the claustrum corresponds closely with the length and height of the insula.

Nucleus Amygdalæ.—The amygdaloid nucleus lies partly in the anterior wall of the anterior end of the inferior horn of the lateral ventricle and partly in the adjacent portion of the roof of the inferior horn. It is continuous with the tail of the caudate nucleus; with the antero-inferior part of the putamen of the lentiform nucleus; with the anterior perforated substance, and with the grey matter of the piriform area of the hippocampal gyrus.

Nuclei of the Thalamus.—When sections of the thalamus are examined it will be noticed that it is surrounded, except on its medial surface, by white matter.

The thin layer of white matter on the superior surface is termed the *stratum zonale.* It consists of fibres derived partly from the optic tract and partly from the optic radiation of the internal capsule. The white lamina on the lateral surface, which separates the grey matter from the internal capsule, is the *external medullary lamina.* The lower surface rests, anteriorly, on the hypothalamus and the temporal peduncle of the thalamus (p. 470) and posteriorly on the upper part of the tegmentum of the cerebral peduncle.

The grey matter of the thalamus is divided into three portions or nuclei by the internal medullary lamina, which consists of a posterior stem and two anterior branches. The portion of the thalamus which lies between the two branches of the internal medullary lamina is the *anterior nucleus.* It is connected with the mamillary body of the same side by the fasciculus mamillo-thalamicus. The part of the thalamus lateral to the stem and the lateral branch of the internal medullary lamina is the lateral nucleus. It is longer than the medial nucleus and includes the whole of the posterior end of the thalamus. The remaining part of the thalamus is the medial nucleus; it lies between the internal medullary lamina and the grey matter of wall of the third ventricle, but extends, backwards, only as far as the trigonum habenulæ.

The thalamus is connected with the cortex of the hemisphere by bundles of fibres which are called the stalks or peduncles of the thalamus; they are the frontal, the parietal, the temporal and the occipital.

The frontal peduncle consists of fibres which emerge from the antero-lateral part of the thalamus and pass, in the anterior part of the internal capsule, to the frontal area of the cortex of the hemisphere. The parietal peduncle springs from the lateral part of the thalamus and passes partly through the internal and external capsules, and partly through the lentiform nucleus, to the parietal lobe and the posterior part of the frontal lobe. The temporal peduncle or ventral stalk is formed by fibres which spring from the cells of the medial and lateral nuclei. They issue from the lower surface of the anterior part of the thalamus and pass, below the lentiform nucleus, to the temporal lobe and the insula. The occipital peduncle springs from the lateral side of the posterior end of the thalamus, in the region of the pulvinar, and its fibres form the optic radiations. They pass through the posterior

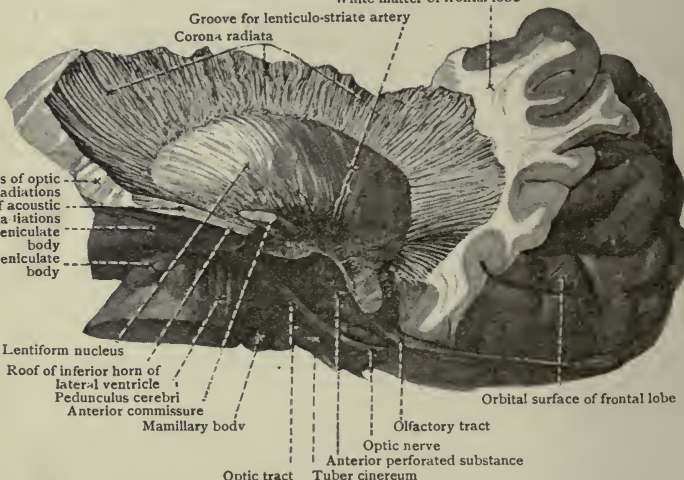


FIG. 189.—Dissection of the right Lentiform Nucleus and the right Corona Radiata from the lateral side.

or retro-lentiform part of the internal capsule and are distributed to the cortex of the occipital lobe, especially in the region of the calcarine fissure (Figs. 182, 191).

Dissection.—Take the lower part of the remains of the right hemisphere and from its lateral side tear away the grey and white matter of the insula, then the claustrum, and, finally, the external capsule, to expose the lateral surface of the lentiform nucleus. As this is being done note the fibres which pass through the region of the limen insulæ and connect together the frontal and the temporal lobes; they constitute the *fasciculus uncinatus*. Note also that the white layer which lies below the lentiform nucleus contains—(1) In its posterior part, the fibres of the acoustic radiations; (2) In its anterior part the fibres of the temporal peduncle of the thalamus; and in addition the fibres of the anterior commissure pass through it on their way to the temporal lobe. Define the fibres of the anterior commissure (Fig. 189) and trace them forward and medially, to the medial face of the section, by removing the anterior perforated substance, which lies below them.

The fibres which lie anterior and posterior to the lentiform nucleus are fibres of the internal capsule. The anterior fibres can be traced downwards to the basis pedunculi, but those of the posterior part, which are fibres of the acoustic and optic radiations, turn medially towards the posterior part of the thalamus and the medial geniculate body.

Make a similar dissection on the upper segment of the right hemisphere to expose the upper part of the lateral surface and the upper border of the lentiform nucleus. Note that the white matter which appears at the upper border of the lentiform nucleus consists of fibres of the internal capsule, which are passing vertically into the corona radiata, and of some longitudinally directed fibres which form the superior longitudinal fasciculus (Fig. 188). Now remove the lentiform nucleus and expose the remainder of the lateral surface of the internal capsule. Finally, trace the main mass of the capsule downwards into the basis pedunculi of which they form the middle three-fifths; the lateral and medial fifths being formed by fibres passing from the temporal and frontal lobes to the pons. Preserve the pieces of the right hemisphere so that the continuity of the motor fibres of the anterior two-thirds of the posterior division of the capsule with the cerebro-spinal fibres of the pons and medulla can be demonstrated at a later stage.

When the dissection of the right hemisphere is completed turn to the posterior vertical section of the left hemisphere and expose the internal capsule from the lateral side by removing, in turn, the remains of the insula, the claustrum, the external capsule, and the lentiform nucleus; then trace the fibres of the internal capsule of the left side downwards into the basis pedunculi.

Complete the dissection of the right hemisphere by tracing the fasciculus mamillo-thalamicus upwards from the mamillary body into the anterior nucleus of the thalamus.

Capsula Interna.—The internal capsule is a relatively thick lamina of white substance by means of which associations are established between the cortex of the hemisphere, its basal nuclei, the lower parts of the brain, and the medulla spinalis. It lies between the caudate nucleus and the thalamus, on the medial side, and the lentiform nucleus on the lateral side, but it extends both anterior and posterior to the lentiform nucleus, and therefore consists of lentiform, pre-lentiform, and retro-lentiform portions. It is continuous, below, with the basis pedunculi and above with the corona radiata, and the lentiform part is bent upon itself, round the medial angle of the lentiform nucleus. The bend, which is known as the *genu*, lies between, and unites together, the anterior and posterior divisions of the lentiform portion of the capsule. Through the anterior division, which lies between the lentiform and caudate nuclei, pass the fibres of the anterior peduncle of the thalamus, and fronto-pontine fibres which associate the cells of the frontal part of the cortex of the hemisphere with the nerve cells of the ventral part of the pons. The genu consists of fibres which convey motor impulses from the motor area of the cortex of the hemisphere to the nuclei of the nerves which supply the muscles of the face and tongue of the opposite side. The posterior division of the lentiform

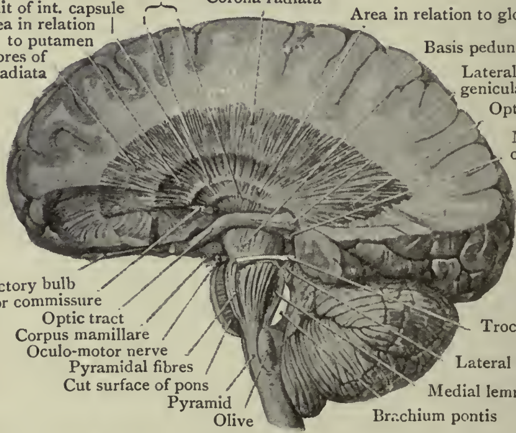


FIG. 190.—Dissection of Internal Capsule and Pyramidal Fibres.

portion of the capsule, which lies between the lentiform nucleus and the thalamus, is separable into (1) an anterior two-thirds, which consists principally of fibres conveying motor impulses to the nuclei of the nerves which supply the muscles of the upper limb, trunk, and lower limb of the opposite side, in that order from before backwards, together with some sensory fibres; and (2) a posterior third, which contains sensory fibres, that is, fibres conveying ordinary sensory impulses to the cortex of the hemisphere. The majority, if not all, of the sensory fibres spring from the thalamus, and they pass to the parietal, occipital, and temporal lobes. The fibres which spring from the posterior part of the thalamus and pass through the posterior or retro-

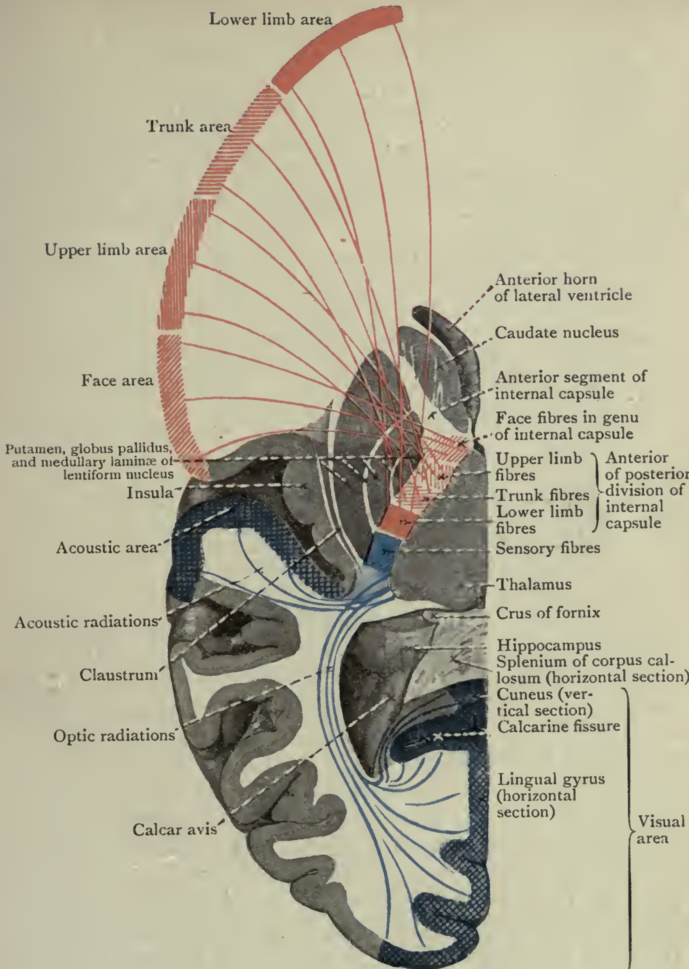


FIG. 191.—Diagram showing the Motor and the Acoustic and Visual Areas of Left Hemisphere and their relations to the Internal Capsule.

The internal capsule and the auditory and visual areas are seen in horizontal section. The motor areas, in red, are supposed to be in vertical section and to be placed at right angles to the horizontal section.

The area of ordinary sensation is not shown, but the fibres from it lie mainly in the posterior third of the posterior division of the internal capsule.

lentiform part of the capsule, and then along the lateral wall of the posterior horn of the lateral ventricle to their distribution in the visual area of the occipital cortex, are called the *optic radiations* (Fig. 191).

Through the posterior part of the internal capsule in the retro-lentiform area, but at a lower level than the optic radiations, there passes a series of fibres, from the medial geniculate body to the temporal lobe, which constitute the *acoustic radiations* (Fig. 191).

Capsula Externa.—The external capsule is a relatively thin lamina of white matter which intervenes between the lentiform nucleus and the claustrum. It is continuous, anteriorly and posteriorly, with the internal capsule, and, above, with the corona radiata. It blends, below, with the sheet of white fibres which separates the lentiform nucleus from the roof of the inferior horn of the lateral ventricle.

THE PARTS OF THE BRAIN WHICH LIE IN THE POSTERIOR CRANIAL FOSSA.

The parts of the brain which lie below the tentorium cerebelli in the posterior cranial fossa are the *lower part of the mid-brain*, the *pons*, the *medulla oblongata*, and the *cerebellum.* The mid-brain has been considered already. The cerebellum, the medulla oblongata, and the pons constitute collectively the rhombencephalon or hind brain, and they are grouped around the *fourth ventricle* of the brain. The fourth ventricle is a cavity which communicates below with the central canal of the medulla spinalis, and above with the aquæductus cerebri.

Medulla Oblongata.—The medulla oblongata is the continuation of the spinal medulla into the brain. It is nearly 30 mm. long (*rather more than one inch*), and may be reckoned as beginning at the level of the foramen magnum. Thence it proceeds upwards, in an almost vertical direction (Fig. 188), and it ends at the lower border of the pons. At first, its girth is similar to that of the spinal medulla, but it rapidly expands as it approaches the pons, and consequently it presents a more or less conical appearance. Its anterior surface lies in the groove on the basilar portion of the occipital bone, and its posterior surface is sunk into the vallecula of the cerebellum.

The bilateral construction of the medulla oblongata is indicated by the appearance of its exterior, for the antero-median and postero-median sulci on the surface of the spinal medulla are prolonged upwards on the anterior and posterior surfaces of the medulla oblongata.

The *antero-median fissure*, as it passes from the spinal medulla on to the medulla oblongata, is interrupted, at the level of the foramen magnum, by several strands of fibres

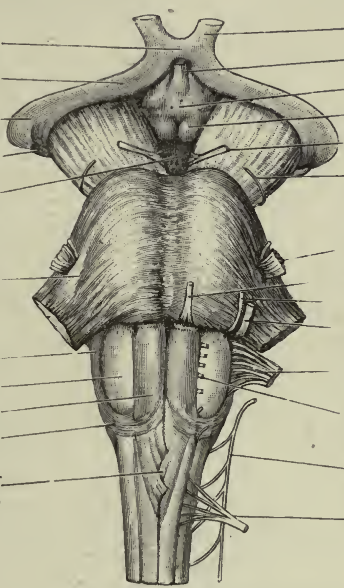


FIG. 192.—Anterior aspect of the Medulla Oblongata, Pons, and Mesencephalon of a full-time Fœtus.

which cross the median plane from one side to the other. This intercrossing is termed the *decussation of the pyramids*. Above the level of the decussation the furrow passes upwards to the lower border of the pons. There it expands slightly, and ends in a blind pit, termed the *foramen cæcum*.

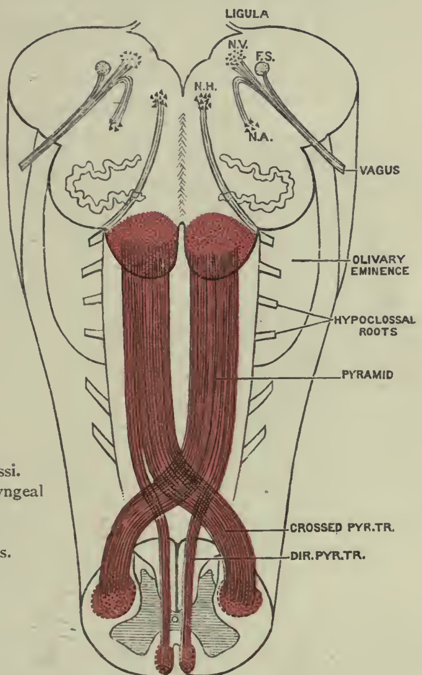
The *postero-median fissure* runs upwards for only half the length of the medulla oblongata. Then the central canal, continued upwards from the medulla spinalis, becomes the fourth ventricle of the brain. As the canal expands dorsally it pushes aside the lips of the posterior median fissure till the epithelium of the posterior wall of the central canal appears on the surface, and forms the posterior wall or roof of the lower part of the fourth ventricle in the triangular interval between the diverging posterior funiculi of the medulla oblongata.

The surface of each half of the medulla oblongata should now be studied. It is well, however, to defer the examination of the medullary part of the floor of the fourth ventricle till a later period. The dissector has already noticed two linear rows of nerve fila issuing from and entering the medulla oblongata on each side. The *anterior row* consists of the fila of the hypoglossal nerve and the uppermost fila of the anterior root of the first cervical nerve. They continue along the side on the medulla oblongata in the line of the anterior nerve roots of the spinal medulla, and they emerge along the bottom of a more or less distinct groove. The *posterior row* is formed of the nerve fila of the accessory, vagus, and glossopharyngeal nerves. As they enter they lie in series with the posterior roots of the spinal nerves.

By these two rows of nerve fila, each side of the medulla oblongata is divided into three districts, viz., an anterior, a lateral, and a posterior, similar to the surface areas of the three funiculi of each half of the medulla spinalis. At first sight, indeed, they appear to be direct continuations upwards of the funiculi of the spinal medulla; it is easily demonstrated, however, that that is not the case, and that the fibres in the three funiculi of the medulla spinalis undergo a rearrangement as they are traced into the medulla oblongata.

Anterior Area of the Medulla Oblongata—Pyramis.—The district between the antero-median fissure and the row of hypoglossal nerve fila issuing from the medulla receives the name of the *pyramid.* An inspection of the surface is almost sufficient to show that the pyramid is formed by a compact mass of longitudinally directed fibres. It expands somewhat, and assumes a more prominent appearance as it passes upwards, and, finally, as it reaches the lower border of the pons, it becomes slightly constricted and disappears from view by plunging into the pons. The pyramids are the great motor strands of the medulla oblongata.

The pyramid, at first sight, appears to be the continuation upwards of the anterior funiculus of the spinal medulla, but it contains also a large number of fibres which, at a lower level, lie in the lateral funiculus. That will be realised if the *decussation of the pyramids* is examined. For that purpose introduce the back of the knife-blade into the antero-median fissure below the decussation, and on one side push in a lateral direction the anterior funiculus of the medulla spinalis. The pyramid will then be seen to divide into two



N.H. Nucleus hypoglossi.
N.V. Vago-glosso-pharyngeal nucleus.
F.S. Tractus solitarius.
N.A. Nucleus ambiguus.

FIG. 193.—Diagram of the Decussation of the Pyramids. (Modified from Van Gehuchten.)

portions, viz., a small strand termed the *fasciculus cerebrospinalis anterior* (O.T. *direct pyramidal tract*), which proceeds downwards into the anterior funiculus of the spinal medulla close to the antero-median fissure, and a much larger strand called the *fasciculus cerebrospinalis lateralis* (O.T. *crossed pyramidal tract*), which, at the level of the decussation, is broken up into three or more coarse bundles which sink backwards and, at the same time, cross the median plane to take up a position in the opposite lateral funiculus of the spinal medulla, close to the posterior column of grey matter. It is the intercrossing of the corresponding bundles of the lateral cerebro-spinal fasciculi of opposite sides which produces the characteristic decussation.

But whilst the fasciculus cerebrospinalis anterior of the anterior funiculus and the fasciculus cerebrospinalis lateralis of the opposite lateral funiculus of the spinal medulla are

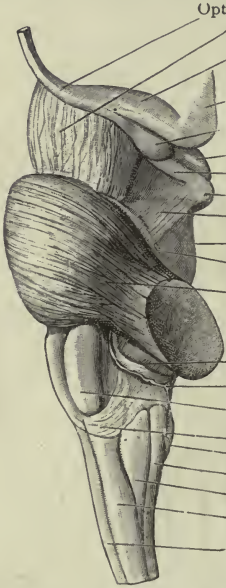


FIG. 194.—Lateral view of the Medulla Oblongata, Pons, and Mesencephalon of a full-time Fœtus.

both represented in one district of the medulla oblongata, it may be asked: What becomes of the larger lateral part of the anterior funiculus of the spinal medulla in the medulla oblongata? It is thrust backwards by the decussating bundles of the lateral cerebro-spinal fasciculus, and occupies a deep position in the medulla oblongata.

Lateral Area of the Medulla Oblongata.—The lateral area is the district on the surface of the medulla oblongata which is included between the two rows of nerve fila, viz., the hypoglossal fila anteriorly, and the fila of the accessory, vagus, and glosso-pharyngeal posteriorly. It presents a very different appearance in its upper and lower parts. In its lower portion it appears to the eye as a continuation upwards of the lateral funiculus of the spinal medulla; in its upper part the striking oval prominence, named the *olive*, is seen.

The lower part of the district, however, is very far from being an exact counterpart of the lateral funiculus of the spinal medulla. It has been noted already that the large fasciculus cerebrospinalis lateralis, which in the spinal medulla lies in the lateral funiculus, is not present in that district of the medulla oblongata; above the decussation of the pyramids it forms the chief part of the pyramid of the opposite side. Another small strand of fibres, the *dorsal spino-cerebellar fasciculus* (O.T. *direct cerebellar tract*), prolonged upwards in the lateral funiculus of the spinal medulla, gradually leaves the lateral portion of the medulla oblongata. The tract of fibres in question lies on the surface, and it is often visible to the naked eye as a white streak inclining obliquely into the posterior district of the medulla oblongata to join its upper part, which is called the *restiform body*. The great majority of the remainder of the fibres which are prolonged upwards from the lateral funiculus of the spinal medulla disappear from the surface at the lower border of the olive, by dipping into the substance of the medulla oblongata under cover of that projection. A narrow band, however, passes upwards to the pons, in the interval between the posterior border of the olive and the fila of the vagus and glosso-pharyngeal nerves.

The *olive* is a smooth, oval prominence, which occupies the upper part of the lateral area of the medulla oblongata. Its long axis, which is vertical, is about 12.5 mm. (*half an inch*) long, and its upper end is separated from the lower border of the pons by an interval or groove.

Posterior Area of the Medulla Oblongata.—The constituent parts of the lower half of the posterior region are the cuneate and gracile funiculi; in its upper half they are the ependymal roof of the fourth ventricle, medially, and the diverging funiculi, laterally.[1] It is separated from the lateral area on each

[1] The dissector should note that the lower part of the cavity of the hind-brain, *i.e.* the fourth ventricle, is not behind but *in* the upper part of the medulla, which it separates into dorsal and ventral parts; the dorsal part forms a portion of the roof of the ventricle, whilst the ventral part forms a portion of the floor.

side by the row of fila belonging to the accessory, vagus, and glosso-pharyngeal nerves.

The lower part of the posterior area corresponds more or less closely with the posterior funiculus of the spinal medulla. It will be remembered that in the cervical part of the spinal medulla the posterior funiculus, on each side, is divided, by a distinct septum of pia mater, into a postero-median strand, the fasciculus gracilis, and a postero-lateral strand, the fasciculus cuneatus. The two strands are prolonged upwards into

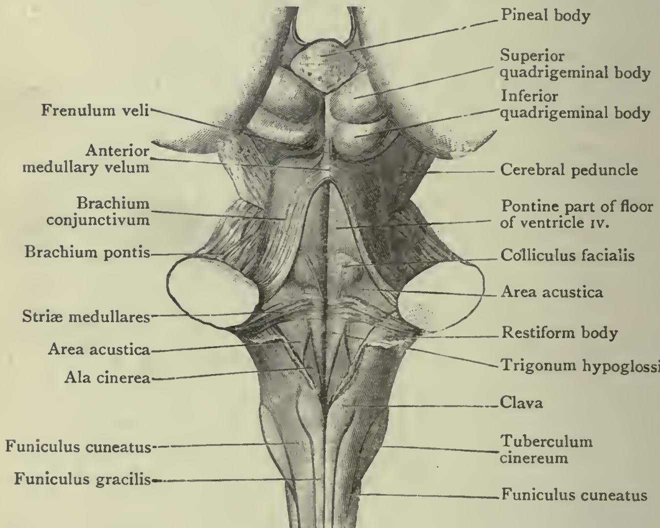


FIG. 195.—Posterior view of the Medulla Oblongata, Pons, and Mesencephalon of a full-time Fœtus. The greater part of the roof of the fourth ventricle is removed.

the medulla oblongata. In the lower part of the posterior area they stand out distinctly, and are separated from one another by the postero-intermediate sulcus, which is continued upwards from the medulla spinalis. Each strand, when it reaches the lower part of the fourth ventricle, ends in a slightly expanded prominence. The swollen extremity of the fasciculus gracilis is called the *clava*; it is thrust aside from its fellow of the opposite side by the opening up of the central canal to form the fourth ventricle.

In sections at the level of the lower part of the fourth ventricle, it is seen that the prominences produced by the two strands and their enlarged extremities are in a great measure due to the presence of two elongated nuclei, which lie subjacent to them and gradually increase as they are traced upwards. These are termed the *gracile* and the *cuneate nuclei*, and as the grey matter increases in quantity the fibres of the two corresponding strands diminish in number. Indeed, it is doubtful if any of the fibres are prolonged upwards beyond the level of the nuclei.

But a third longitudinal elevation also is apparent in the lower part of the posterior area of the medulla oblongata. It is placed on the lateral side of the fasciculus cuneatus—between it and the posterior row of nerve fila—and it has no counterpart in the posterior funiculus of the spinal medulla. It is called the *funiculus of Rolando*, because it is produced by the substantia gelatinosa (Rolandi) approaching the surface. Extremely narrow below, the funiculus of Rolando widens somewhat as it is traced upwards, and it, finally, ends in an expanded extremity called the *tuberculum cinereum*. The thin layer of fibres which appear on the surface of the tuberculum cinereum, and cover the substantia gelatinosa (Rolandi), in that position, belong to the tractus spinalis (O.T. spinal root) of the trigeminal nerve.

The *restiform body* forms the upper part of the posterior area on each side. It lies between the lower part of the floor of the fourth ventricle and the fila of the vagus and glosso-pharyngeal nerves, and is thrust laterally by the enlargement of the fourth ventricle. It is a relatively large rope-like strand, which inclines upwards and laterally, and then, finally, it takes a turn backwards, and enters the cerebellum, of which it constitutes the *inferior peduncle*. The restiform body, therefore, is to be regarded as the main connection between the cerebellum, above, and the medulla oblongata and medulla spinalis, below. At the same time, it must be understood that it is not formed of fibres which are prolonged into it from the fasciculus gracilis and fasciculus cuneatus of its own side, although a surface inspection of the medulla oblongata might lead very naturally to that supposition, because there is no sharp line marking it off from the ends of those strands.

The fibres which build up the restiform bodies come from several different sources. It will be sufficient to indicate the more important of them—

(1) fibres from the lateral funiculus of the spinal medulla, through the *dorsal spino-cerebellar fasciculus*; (2) *olivo-cerebellar fibres* from the opposite inferior olivary nucleus to the cerebellum; (3) fibres from the cuneate and gracile nuclei of both sides in the form of the *arcuate fibres*.

Fibræ Arcuatæ Externæ.—On the surface of the medulla oblongata, more particularly in the neighbourhood of the lower border of the olive, a number of curved bundles of fibres, termed the *external arcuate fibres*, may be noticed. They vary greatly in number and in distinctness, and are sometimes so numerous as to cover the olive almost entirely. An attentive examination will show that they come to the surface (1) in the antero-median fissure between the pyramids, (2) in the groove between the pyramid and the olive, and (3) sometimes also through the substance of the pyramids. But at whatever point they reach the surface, the majority have one destination, viz., the restiform body—a considerable part of which they form. They are derived from the cuneate and gracile nuclei of the opposite side, and end in the cerebellum.

At the inferior end of the olive there is not uncommonly a curved bundle of fibres, called the *circum-olivary fasciculus*, which follows the line of the external arcuate fibres but has a different commencement and termination. It consists of fibres descending from the cerebrum, and corresponds with the fibres of the pons which end round the pontine nuclei.

Dissection.—The pyramidal fibres of one side should now be carefully raised. When dislodged from their bed they should be gently pulled upwards towards the pons. In that way their entrance into the pons will be brought very clearly into view. Further, numerous arcuate fibres will be seen running forwards upon the medial aspect of the opposite pyramid to reach the surface, and the ventral edge of the medial lemniscus will be exposed also.

Pons.—The pons is the marked prominence, on the base of the brain, which lies anterior to the cerebellum and is interposed between the medulla oblongata and the pedunculi cerebri (Figs. 160, 194). It is convex from side to side, as well as from above downwards, and the transverse streaks on its surface show that, superficially, it is composed of transverse bundles of nerve fibres. On each side the transverse fibres collect themselves together to form a large compact strand which sinks, postero-laterally, into the corresponding hemisphere of the cerebellum. The strand is termed the *brachium pontis* (O.T. *middle cerebellar peduncle*).

When the brain is *in situ* the *ventral surface* of the pons is in relation to the basilar portion of the occipital bone, the dorsum sellæ of the sphenoid bone, and the medial parts of the posterior surfaces of the petrous portions of the temporal bones. It presents a median groove which gradually widens as it is traced upwards (Fig. 192). The groove lodges the basilar artery, but is not caused by that vessel; it is due to the prominence produced, on each side, by the passage downwards, through the pons, of the bundles of fibres which form the pyramids of the medulla oblongata. Where the pons becomes the brachium pontis the large trigeminal nerve is attached to its ventral surface, nearer its upper than its lower border.

With the exception of the restiform bodies, which pass backwards into the cerebellum, most of the constituent parts of the medulla oblongata are continued into the pons. The pedunculi cerebri emerge from the upper aspect of the pons.

The *dorsal surface* of the pons cannot be studied at present. It is turned towards the cerebellum, which hides it from view, and it forms the upper part of the anterior boundary or floor of the fourth ventricle.

Cerebellum.—The cerebellum is distinguished by the numerous parallel and more or less curved sulci which traverse its surface and give it a foliated appearance. As in the case of the cerebral hemispheres, the grey matter is spread over the entire surface, whilst the white matter forms a central core in the interior.

The cerebellum consists of a median portion, the *vermis*, and two *hemispheres*, but the distinction between those main subdivisions of the organ is not very evident on its superior surface. Anteriorly and posteriorly there is a marked deficiency or notch in the median plane (Fig. 197). The *posterior notch* is smaller and narrower than the anterior notch. It is bounded on each side by the posterior parts of the cerebellar hemispheres, and anteriorly by the vermis, and it is occupied by the falx cerebelli. The *anterior notch* is much wider and, when viewed from above, it is seen to be occupied by the inferior colliculi of the quadrigeminal lamina and the brachia conjunctiva cerebelli. Its sides are formed by the hemispheres, and the posterior end is bounded by the vermis.

On the *superior surface* of the cerebellum there are, as already stated, no definite lines of demarcation between the vermis and the upper surfaces of the hemispheres. The upper part of the vermis forms a median ridge, from which the surface slopes gradually downwards, on each side, to the margin of the corresponding hemisphere. On the upper part of the vermis four regions are recognised. Anteriorly, at the posterior end of the anterior notch, lies the *central lobe*, and prolonged upwards from it on the dorsal surface of the anterior medullary velum, between the brachia conjunctiva, are a few folia which constitute the *lingula*. Posterior to the central lobe is the *monticulus*, separable into two parts—an anterior, more elevated portion, the *culmen*, and a posterior, sloping ridge, the *declive*. Posterior to the declive, in the anterior boundary of the posterior notch, lies a single folium called the *folium vermis*.

On the *inferior surface* of the cerebellum, the distinction between the three constituent parts of the organ is much better marked. On that aspect the hemispheres are full, prominent and convex, and they are separated by a deep, median hollow which is continued forwards from the posterior notch. The hollow is termed the *vallecula cerebelli*, and in its anterior part the medulla oblongata is lodged. If the medulla is forced away from the cerebellum, and the hemispheres are pulled apart so as to expose the upper boundary of the vallecula, it will be seen that that boundary is formed by the inferior surface of the *vermis*, and, further, that the vermis is separated, on each side, from the corresponding hemisphere by a distinct furrow, termed the *sulcus valleculæ*.[1]

If the margin of the vermis, where it forms the posterior boundary of the anterior notch on the superior aspect of the cerebellum, is gently raised, and at the same time the mesencephalon is pulled forwards, two strands lying upon the dorsal aspect of the pons will be seen. These are the *brachia conjunctiva cerebelli* (O.T. *superior peduncles*). They emerge from the white matter of the cerebellum, converge as they proceed upwards, and, finally, they disappear under the inferior quadrigeminal bodies. The thin lamina which is stretched across between them is the *anterior medullary velum*. It is continuous below with the white core of the vermis, and it helps to form the roof of the upper part of the fourth ventricle. From its dorsal surface, close

[1] As the medulla oblongata is displaced forwards, and the hemispheres of the cerebellum are pulled apart, the epithelial roof of the fourth ventricle and its covering of pia mater will be torn away, and the lower part of the floor or anterior boundary of the fourth ventricle will be displayed.

to the inferior quadrigeminal body, the small trochlear nerves emerge.

Certain of the sulci which traverse the surface of the cerebellum, deeper and longer than the others, map out districts which are termed lobes. The most conspicuous of all the clefts is the *horizontal sulcus.*

Sulcus Horizontalis Cerebelli.—The horizontal sulcus begins anteriorly, where its lips separate from one another to enclose the large brachia pontis, and it passes round the

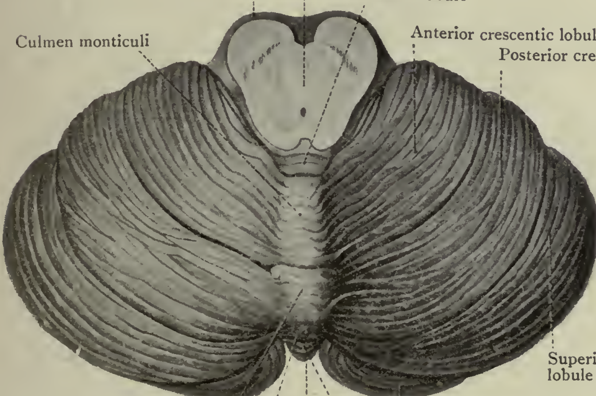


FIG. 196.—Upper surface of the Cerebellum.

circumference of the cerebellum, cutting deeply into its lateral and posterior margins. By means of the horizontal sulcus the cerebellum is divided into an upper and a lower part, which may be studied separately.

Lobes on the Upper Surface of the Cerebellum.—It has been noted already that the upper surface of the vermis superior is subdivided. The divisions, commencing at the anterior end, are :—(1) the lingula ; (2) the central lobule ; (3) the culmen monticuli ; (4) the declive monticuli ; (5) the folium vermis. With the exception of the lingula, each part is continuous on each side with a corresponding district on the upper surface of the hemisphere, and forms with those districts a cerebellar lobe. Thus, the central lobule is prolonged laterally on each side in an expansion called the *ala* ;

the culmen constitutes a median connecting piece between the two *anterior crescentic lobules* of the hemispheres; the declive stands in the same relation to the *posterior crescentic lobules*; and the folium vermis is the connecting band between the *superior semilunar lobules* of the hemispheres.

Lingula.—The lingula can be seen only when the posterior boundary of the anterior notch is pushed backwards. It consists of four or five small folia, continuous with the grey matter of the vermis, prolonged upwards on the surface of the anterior medullary velum, in the interval between the brachia conjunctiva.

Lobus Centralis with its Alæ.—The central lobule lies at the posterior

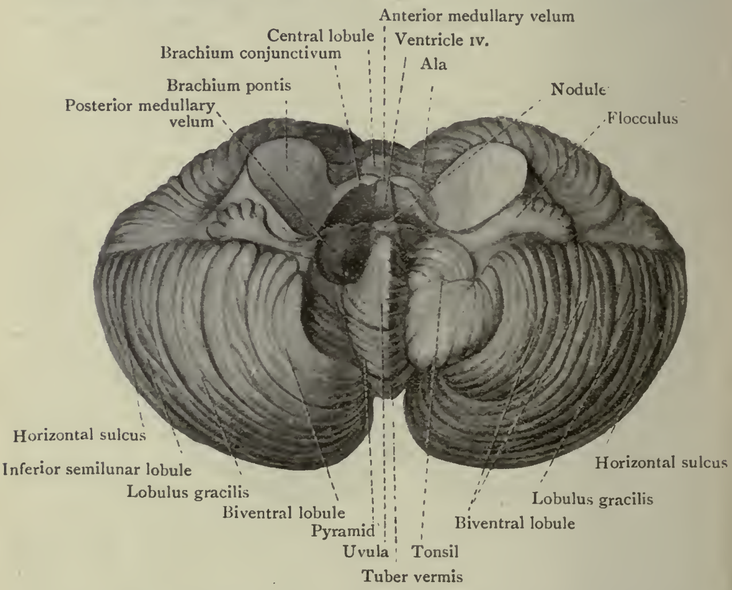


FIG. 197.—Lower surface of the Cerebellum. The tonsil of the right side has been removed so as to display the posterior medullary velum and the furrowed band.

end of the anterior notch, and is largely hidden by the culmen. It is a little median mass which is prolonged laterally for a short distance round the semilunar notch in the form of two expansions, termed the *alæ*.

Lobus Culminis.—The *culmen monticuli* constitutes the summit or highest part of the monticulus of the vermis. It is prolonged laterally on each side into the corresponding hemisphere as the *anterior crescentic lobule*. This is the most anterior subdivision on the upper surface of the hemisphere. The two anterior crescentic lobules, with the culmen monticuli, form the *lobus culminis cerebelli*.

Lobus Declivis.—The *declive monticuli* lies posterior to the culmen, from which it is separated by a distinct fissure, and it forms the sloping part or descent of the monticulus of the vermis. On each side it is continuous with the *posterior crescentic lobule* of the hemisphere, and the three parts are included under the one name of *lobus declivis.*

The two crescentic lobules on the upper surface of the hemisphere are frequently described together as the *quadrate lobule.*

Lobus Semilunaris Superior (O.T. **Lobus Cacuminis**).—The *folium vermis* forms the most posterior part of the superior portion of the vermis, and it bounds the horizontal fissure, superiorly, at the posterior notch. It is a single folium, the surface of which may be smooth or notched with rudimentary secondary folia, and it is the connecting link between the two *superior semilunar lobules* of the hemispheres—the three parts constituting the *lobus semilunaris superior.* As the folium vermis is traced laterally into the semilunar lobule of the hemisphere, it is found to expand greatly. The result is that the lobus semilunaris superior, on each side, forms an extensive foliated district bounding the posterior part of the horizontal sulcus superiorly.

Lobes on the Lower Surface of the Cerebellum.—The connection between the several portions of the inferior part of the vermis, and the

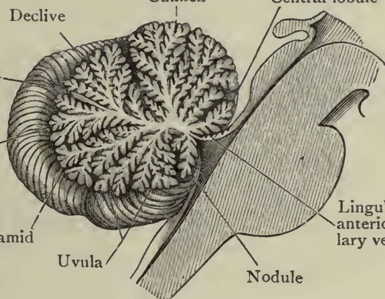


FIG. 198.—Median section through the Vermis of the Cerebellum. (From Gegenbaur.)

corresponding districts on the inferior surface of the two hemispheres is not nearly so distinct as in the case of the superior part of the vermis and the lobules on the upper surface of the hemispheres.

The following subdivisions of the inferior part of the vermis are recognised, from behind forwards—(1) the tuber vermis, (2) the pyramid, (3) the uvula, and (4) the nodule.

On the inferior surface of the hemisphere there are five lobules mapped out by intervening sulci. They are—(1) the *flocculus*, a little lobule lying on the brachium pontis; (2) the *biventral lobule*, which lies immediately posterior to the flocculus, and is partially divided into two parts by a fissure which traverses its surface; (3) the *tonsil*, a rounded lobule, which bounds the vallecula on the medial side of the biventral lobule; (4) the *inferior semilunar lobule*, placed posterior to the biventral lobule, and bounding the horizontal sulcus inferiorly.

The lobules of the inferior parts of the hemispheres, with the corresponding portions of the inferior part of the vermis, constitute the lobes on the inferior aspect of the cerebellum.

Lobus Noduli.—The lobus noduli comprises the nodule and the flocculus, of each side, with an exceedingly delicate connecting lamina of white matter, termed the *posterior medullary velum.*

The velum cannot be properly seen at present, but it will be exposed at a later stage of the dissection.

Lobus Uvulæ.—The uvula is a triangular elevation placed between the two tonsils. It is connected, across the sulcus valleculæ, with each tonsil by a low-lying ridge of grey matter which is scored by a few shallow furrows, and in consequence termed the *furrowed band.* The two tonsils and the uvula form the *lobus uvulæ.*

To see the furrowed band it will be necessary to remove the tonsil on one side, when the posterior medullary velum also will be exposed.

Lobus Pyramidis.—The pyramid is connected with the biventral lobule on each side by a faint ridge which crosses the sulcus valleculæ. The term *lobus pyramidis* is given to the three lobules which are thus associated with each other.

Lobus Tuberis.—The *tuber vermis*, which forms the most posterior part of the inferior vermis, is composed of several folia, which run directly into the inferior semilunar lobule on each side. The three parts of the *lobus tuberis* are thus linked together. The inferior semilunar lobule is traversed by two, or it may be three, curved fissures. The most anterior of these cuts off a narrow, curved strip of cerebellar surface called the *lobulus gracilis.*

***Dissection.*—A median section should now be made through the vermis of the cerebellum and the two medullary vela into the cavity of the fourth ventricle. When the two parts of the cerebellum are drawn slightly asunder, a view of the fourth ventricle is obtained; further, the connections of the two medullary vela and the arrangement of the peduncles of the cerebellum can be more clearly understood.**

Arbor Vitæ Cerebelli.—The cut surface of the cerebellum presents a very characteristic appearance. The grey matter on the surface stands out distinctly from the white matter in the interior. Further, the complete manner in which the surface is cut up by the sulci into secondary and tertiary folia is seen. The central mass of white matter in the vermis is termed the *corpus medullare.* From the corpus medullare, prolongations pass into the various lobules, and they give off branches to supply each folium with a central white stem or core. The term *arbor vitæ* is applied to the appearance which consequently results when a section is made through the cerebellum (Fig. 198).

Cerebellar Peduncles.—The cerebellar peduncles are the structures which connect the cerebellum with the medulla oblongata, the pons and the mid-brain. They are three in number on each side—viz., the inferior, the middle, and the superior. They are all directly connected with the white medullary centre of the cerebellum, and are composed of fibres which emerge from or enter the white central substance of the organ.

The *middle peduncle* or brachium pontis is much the largest of the three. It is formed by the transverse fibres of the pons, and it enters the cerebellar hemisphere on the lateral side of the other two. The lips of the anterior part of the horizontal sulcus are separated widely from each other to give it admission (Fig. 195).

The *inferior peduncle* is the restiform body of the medulla oblongata. As it leaves the dorsum of the medulla oblongata it turns sharply backwards and enters the cerebellum between the other two peduncles.

The *superior peduncles* are the brachia conjunctiva of the cerebellum. They are composed of fibres which come, for the most part, from the nucleus dentatus of the cerebellar hemisphere. As they issue from the cerebellum, the peduncles lie close to the medial sides of the corresponding middle peduncles. They then proceed upwards towards the inferior pair of quadrigeminal bodies. At first, they form the lateral boundaries of the upper part of the fourth ventricle, but they converge, as they ascend on the dorsal aspect of the pons, so that ultimately they overhang the fourth ventricle and enter into the formation of its roof. They disappear under cover of the inferior colliculi of the quadrigeminal lamina, and their course in the mesencephalon has been described already (Figs. 180, 181, 194, 195) (p. 457).

Medullary Vela.—The medullary vela are closely associated with the peduncles. They consist of two thin laminæ of white matter which are projected out from the white central core of the cerebellum. The *anterior medullary velum* stretches across the interval between the two brachia conjunctiva (superior peduncles), with the medial margins of which it is directly continuous. It is triangular in form, and is continuous below with the white matter of the cerebellum. Spread out on its dorsal surface is the tongue-shaped prolongation of grey matter from the cortex of the cerebellum which is termed the *lingula*, and issuing from its substance, close to the inferior colliculi of the quadrigeminal lamina, are the two trochlear nerves.

The *posterior medullary velum* is somewhat more complicated in its connections. It presents the same relation to the nodule that the anterior velum presents to the lingula. It is a wide thin lamina of white matter—so thin that it is translucent—which is prolonged out from the white centre of the cerebellum above the nodule. From the nodule it stretches laterally to the flocculus, thereby bringing those two small portions of the cerebellum into association with each other. Where it issues from the white matter of the cerebellum it might almost be said to be in contact with the anterior medullary velum, but as the two laminæ are traced forwards they diverge from each other: the anterior velum is carried upwards between the brachia conjunctiva of the cerebellum, whilst the posterior medullary velum turns downwards, round the nodule, and ends in a slightly thickened free crescentic edge. The cavity of the fourth ventricle passes backwards between the two vela, which form a tent-like roof for it.

Isthmus Rhombencephali.—If the dissector examines the rhombencephalon from the side he will recognise that there is a region below the lamina quadrigemina and above the cerebellum which is bounded dorsally by the anterior medullary velum, laterally by the brachia conjunctiva, and ventrally by the upper part of the pons; it is to that region that the term isthmus rhombencephali is applied. It contains the upper part of the fourth ventricle.

Ventriculus Quartus.—The fourth ventricle is somewhat rhomboidal in form. Below, it tapers to a point and becomes continuous with the central canal of the lower part of the medulla oblongata; above, it narrows, in a similar manner, and is continued into the aquæductus cerebri of the mid-brain. The anterior wall is termed the *floor*, and is formed by the dorsal surface of the pons and the ventral part of the upper portion of the medulla oblongata. The posterior wall is called the *roof*. On each side a narrow pointed prolongation of the widest part of the ventricular cavity passes laterally round the upper part of the corresponding restiform body. The prolongations are termed the *lateral recesses* and are seen to the greatest advantage when the cerebellum is divided in the median plane and the halves are turned aside.

The lateral boundary of the fourth ventricle, on each side, is formed, from below upwards, by the clava, the upper part of the fasciculus cuneatus, the restiform body or inferior peduncle of the cerebellum, the brachium pontis or middle peduncle of the cerebellum, and the brachium conjunctivum or superior peduncle of the cerebellum.

Dissection.—On one side cut through the brachium conjunctivum, the brachium pontis and the restiform body, and so

separate one half of the cerebellum, which must be laid aside for the present, but must be preserved for future use.

When the dissection is completed the dissectors will be able to recognise that the anterior part of the cavity of the fourth ventricle is rhomboidal in form. It constitutes the so-called *rhomboid fossa*, which is surrounded by the lateral boundaries of the ventricle and closed anteriorly by the pons and the dorsal surface of the ventral part of the upper half of the medulla oblongata. Only the *lower part* of the rhomboid fossa lies in the medulla oblongata; the *middle part* is in the metencephalon, that is, it lies anterior to the cerebellum and posterior to the lower part of the pons; and the *upper part* is in the isthmus rhombencephali.

The *lower part of the rhomboid fossa* is triangular in outline, and its inferior angle is continuous with the central canal of the lower part of the medulla oblongata. The anterior boundary or floor of this part of the fossa is marked by a number of converging sulci, and is called the *calamus scriptorius*. Along the lateral margins of the lower part of the fossa will be seen the remains of the torn epithelial roof of the lower part of the fourth ventricle. The torn margins are the *tæniæ of the fourth ventricle*. The *middle part of the rhomboid fossa* is separable into a lower wider part, which is prolonged laterally, on each side, below and posterior to the restiform body, as the *lateral recess of the fourth ventricle*. The upper section of the intermediate part of the fossa is bounded laterally by the brachia pontis and is much narrower than the lower part. The *upper part of the rhomboid fossa* lies posterior to the pons and between the brachia conjunctiva. At its upper end it becomes continuous with the aquæductus cerebri of the mid-brain.

The *floor, or anterior boundary, of the fossa rhomboidea* is the floor, or anterior boundary, of the fourth ventricle. In the upper part of its extent it is formed by the posterior surface of the pons, and in the lower part by the posterior surface of the ventral part of the upper portion of the medulla oblongata. It is divided into lateral portions by a *median sulcus* which is deeper below, in the region of the calamus scriptorius, and shallower above. On each side of the median sulcus is the *eminentia medialis*. In the upper part of the fossa the eminentia medialis occupies practically the whole of each half of the floor; in the upper part of the middle portion of the fossa a rounded eminence, the *colliculus facialis*, appears on its surface; below the colliculus the eminentia medialis narrows rapidly, and its terminal, tapering portion is called the *trigonum hypoglossi*. The medial eminence is bounded laterally by a sulcus, the *sulcus limitans*. In the upper region, along the lateral border of the sulcus limitans, is a narrow bluish-tinted area called the *locus cæruleus*; the colour of that area is due to a subjacent collection of pigmented cells which constitute the *substantia ferruginea*. Opposite the colliculus facialis the sulcus limitans expands into a shallow fossa, the *superior fovea*. The lower end of the sulcus limitans terminates, in the upper part of the inferior section of the rhomboidal fossa, in a definite depression, the *inferior fovea*. To the lateral side of the superior and inferior foveæ and the middle part of the sulcus limitans is the *area acustica*, which is prolonged laterally towards the lateral recess, and, in rare cases, a prominence, the *tuberculum acusticum*, appears on its surface. Below the inferior fovea, between the trigonum hypoglossi medially and the area acustica laterally, lies a depressed, grey-coloured, triangular area called the *ala cinerea*, which is separated from the lower part of the floor, the *area postrema*, by a raised bundle, the *funiculus separans*. Immediately above the inferior fovea a number of ridges, the *medullary striæ* (O.T. *striæ acusticæ*), cross the floor of the fossa transversely. Laterally, they cross the restiform body, at the lateral border of the fossa, and become continuous with the cochlear root of the acoustic nerve; and, medially, they disappear into the median sulcus (Fig. 195).

The *roof of the fourth ventricle* is formed, in the upper area, by the medial parts of the brachia conjunctiva and the intervening anterior medullary velum. Descending upon the velum, from above, is the frenulum veli; issuing from it, in the same region, are the rootlets of the trochlear nerves. The lower part of the upper portion of the roof is covered by the lingula of the cerebellum. The roof of the intermediate section of the ventricle is the white matter of the vermis of the cerebellum, and the roof of the lower part is reduced to the lining epithelial ependyma with the posterior medullary velum, and the obex (see p. 493).

The *tela chorioidea of the fourth ventricle* is the layer of pia mater which covers and strengthens the epithelial roof of the lower part of the cavity. Between it and the epithelium, at the lower end of the roof, is a thin layer of grey matter, called the *obex*. Above, at the posterior medullary velum, the tela becomes continuous with the pia mater on the lower surface of the vermis of the cerebellum. Laterally the tela is prolonged, on each side, posterior to the restiform body, over the lateral recess, and it forms the stronger part of the wall of that expansion. Between the median part of the tela chorioidea of the fourth ventricle and the pia mater on the lower surface of the vermis of the cerebellum lies the cisterna cerebello-medullaris (O.T. cisterna magna) (Fig. 141).

Apertures in the Tela Chorioidea of the Fourth Ventricle.—In the early stages of development the tela chorioidea and ependyma form an unbroken layer, but at a later period three apertures appear in them. One of the apertures, the *apertura medialis ventriculi quarti* (O.T. *foramen of Magendie*), lies immediately above the obex, at the lower angle of the ventricle, and through it the cavity of the fourth ventricle communicates with the cerebello-medullary portion of the subarachnoid space. The other two apertures lie at the apices of the lateral recesses, immediately posterior to the fila of the glossopharyngeal nerves.

Chorioid Plexuses of the Fourth Ventricle.—The chorioid plexuses are invaginations of the ependyma caused by vascular prolongations of the tela chorioidea. In the lower part of the ventricle they form two parallel bands, one on each side of the median plane, and their lower ends project through the median aperture. At the upper part of the tela chorioidea they communicate together, and then each passes laterally into the corresponding lateral recess and their lateral extremities project through the lateral apertures.

Dissection.—The dissector should now introduce his fingers into the horizontal sulcus of that half of the cerebellum which is still connected with the medulla oblongata and the pons, and tear the upper part of the cerebellum away from the lower part. By that proceeding the manner in which the peduncles enter the white medullary centre, and also, to some extent, the general distribution of their fibres, will be seen.

Next, separate the remains of the cerebellum from the isthmus, the pons, and the medulla oblongata by cutting through the peduncles at the points where they enter the central white matter. A horizontal section may then be made through the other half of the organ, rather nearer its upper surface than its lower surface. The section will reveal the nucleus dentatus.

Nucleus Dentatus.—The dentate nucleus is a collection of grey matter embedded in the white medullary centre of the hemisphere of the cerebellum. Its appearance is very similar to that of a nucleus which lies in the olive of the medulla oblongata. It is a thin lamina of grey matter, which appears, on section, as a wavy line folded upon itself so as to form a crumpled grey capsule with a mouth open towards the median plane. The greater number of the fibres which build up the brachium conjunctivum issue from its mouth.

There are other smaller isolated nuclei of grey matter in the white medullary centre of the cerebellum. They are: the *nucleus emboliformis*, which lies close to the hilum of the dentate nucleus; the *nucleus globosus*, medial to the nucleus emboliformis; and the *nucleus fastigii*, or *roof nucleus*, which is situated in the white matter above the cavity of the fourth ventricle. As a rule, those nuclei cannot be demonstrated in a specimen obtained in the dissecting-room.

Dissection.—Place the lower part of the mid-brain in relation with the upper part, in which the position of the motor fibres, descending from the cortex of the hemisphere, through the anterior part of the posterior division of the internal capsule, has already been defined. Note the position of the motor fibres in the basis pedunculi of the lower part of the mid-brain. They lie, for the main part, in the intermediate three-fifths. On one side trace the motor tract downwards to the upper border of the pons. Then remove the superficial transverse fibres of the pons and trace the motor tract downwards, through the pons. At the lower border of the pons it will be found to become continuous with the ventral (anterior) part of the pyramid of the medulla oblongata. The dissector should note that the tract diminishes somewhat in size as it is followed downwards through the pons.[1] The diminution is due to some of the fibres leaving the tract and passing across the median plane to the nuclei of the cerebral motor nerves of the opposite side. Note that, when the motor tract reaches the lower end of the medulla oblongata, the majority of its fibres cross to the opposite side, to form the lateral cerebro-spinal fasciculus of the lateral funiculus of the spinal medulla of that side, and that the smaller number continue to descend on the same side, to form the anterior cerebro-spinal fasciculus of the anterior funiculus of the same side of the spinal medulla.

Remove the motor tract in the lower part of the mid-brain and in the pons and medulla oblongata, and note the following structures which lie dorsal to it—(1) In the mid-brain a dark pigmented layer, the substantia nigra. (2) In the pons a deep layer of transverse fibres which constitute the corpus trapezoideum. (3) In the medulla oblongata a band of longitudinal white fibres which form part of a long strand called the medial lemniscus.

Lemniscus Medialis.—In the lower part of the medulla

[1] The dissector should note also that other fibres which end in the pons, round the pontine nuclei, are associated with the motor fibres.

oblongata the medial lemniscus consists of fibres which have ascended from the lateral and the anterior funiculi of the spinal medulla, where they form tracts called the lateral and the anterior spino-thalamic fasciculi. In the upper part of the medulla oblongata the spino-thalamic fasciculi are joined

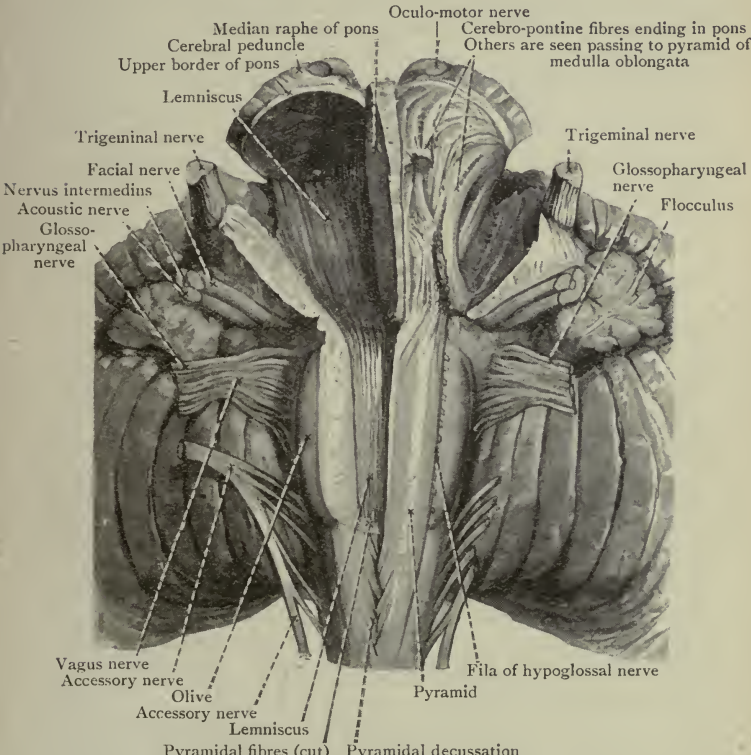


FIG. 199.—Dissection of Pons and Medulla Oblongata to show Pyramidal Fibres and Lemniscus.

by fibres derived from the nucleus gracilis and the nucleus cuneatus of the opposite side. The nucleus gracilis and the nucleus cuneatus lie in the upper ends of the fasciculi of the same names, and the fibres which pass from them to the lemniscus of the opposite side decussate with similar fibres derived from the opposite gracile and cuneate nuclei, in the region between the olivary bodies, and as they decussate they form the *decussation of the lemnisci* or interolivary decussation (Fig. 201).

In addition to the fibres derived from the spino-thalamic fasciculi and the nucleus gracilis and nucleus cuneatus of the opposite side, the lemniscus, whilst it is still in the medulla oblongata, receives fibres from the sensory nuclei of the cerebral nerves of the opposite side.

The portion of the lemniscus found in the medulla oblongata is known as the *medial lemniscus.* It ascends through the pons into the mid-brain, where many of its fibres end in the superior colliculus, but some ascend still higher and terminate in the thalamus of the same side. As the medial lemniscus ascends through the pons it receives additional fibres from the nuclei of the sensory cerebral nerves of the opposite side. The majority of the additional fibres pass to the lemniscus through the corpus trapezoideum, and those derived from the nuclei of the cochlear division of the opposite acoustic nerve attain a position at the lateral border of the medial lemniscus, and they form a more or less separate bundle termed the *lateral lemniscus.* In the region of the upper part of the pons the fibres of the lateral lemniscus turn dorsally, and, after emerging from the upper border of the pons, they cross superficial to the lateral surface of the upper part of the brachium conjunctivum of the cerebellum (Fig. 194), and disappear under cover of the inferior colliculus of the quadrigeminal lamina, and also under the inferior brachium and the medial geniculate body. They terminate in association with the cells of the inferior colliculus, and with those of the medial geniculate body, whence the acoustic radiations already noted (p. 474) pass to the superior temporal gyrus.

Dissection.—To trace the lemniscus upwards it is necessary to remove the deep transverse fibres of the pons, and the substantia nigra of the mid-brain. As the dissector makes the dissection, he should note—(1) That the lemniscus increases in width in the lower part of the pons on account of the accession of fibres from the nuclei of the sensory cerebral nerves of the opposite side. (2) That in the upper part of the pons the lemniscus decreases in width as the lateral portion leaves it to pass to the inferior colliculus.

After the dissector has displayed, as far as possible, the position and connections of the lemniscus he should turn to the brachium conjunctivum of the cerebellum and attempt to demonstrate its associations. It is quite easily recognisable, as it lies behind the upper part of the pons, in the dorso-lateral boundary of the upper part of the fourth ventricle. There, it should be located, and thence it should be traced backwards into the hemisphere of the cerebellum, of the same side, to the dentate nucleus, and forwards, medial to the lateral lemniscus and ventral to the inferior colliculus, into the tegmental part of the cerebral peduncle. As the fibres are traced into the mid-brain they will be found to approach the corresponding fibres of the opposite side, with which they decussate, in the lower part of the mid-brain, dorso-medial to the medial lemniscus. After decussating they pass upwards to the red nucleus of the opposite side, where the majority terminate.

When the dissections described are completed the dissector should make a series of transverse sections through the opposite half of the medulla oblongata and the pons, or, better still, through the whole of another specimen, if it can be obtained. In such a series of sections he will be able to note some of the points now to be mentioned, but the majority of the details noted are well seen only on specially prepared and stained sections.

Internal Structure of the Medulla Oblongata.—When transverse sections are made through the upper part of the medulla oblongata, a faint line, called the median raphe, is seen in the median plane. It divides the medulla oblongata into two exactly similar halves. The raphe is formed by the close intersection of fibres running in opposite directions.

Each half of the medulla oblongata is composed of—(*a*) strands of white matter; (*b*) grey matter, which is present both in the form of direct continuations into the medulla oblongata of portions of the grey matter of the spinal medulla, and in the form of isolated masses, which are not represented in the spinal medulla; (*c*) the formatio reticularis, a substance which is composed of grey matter coarsely broken up by fibres which traverse it in different directions; and (*d*) neuroglia. The white matter, as in the spinal medulla, is disposed, for the most part, on the surface and the grey matter in the interior, but in the open part of the medulla oblongata the grey matter comes to the surface on its dorsal aspect, and forms the obex (p. 496).

When the grey matter of the spinal medulla is traced up into the medulla oblongata, many striking changes in its arrangement become apparent. Owing to the increase in size of the large wedge-shaped gracile and cuneate fasciculi, the posterior columns of grey matter are pressed laterally, so that they soon assume a position at right angles to the median plane. At the same time, the cuneate and gracile nuclear columns of grey matter, which grow out from the basal portion of the posterior column and underlie the strands of the same name, begin to make their appearance. From the deep aspects of those nuclei, fibres, which take origin within them, stream antero-medially through the neck of the posterior grey column to reach the ventral median raphe. And as they pass ventrally they separate the head from the basal part of the posterior grey column. The basal part of the grey column remains close to the central canal, but the head and the substantia gelatinosa remain near the surface, and, towards the upper part of the lower half of the medulla oblongata, the head enlarges and forms a prominence on the surface which has already been noticed as the tuberculum cinereum (p. 481).

The fibres which spring from the cells of the nucleus gracilis and the nucleus cuneatus and break through the neck of the posterior grey column are called the *internal arcuate fibres*. They reach the raphe on the deep or dorsal aspect of the pyramidal fasciculus and, in the median plane at the level of the olives, where they form a very complete decussation with the corresponding fibres of the opposite side, termed the *decussation of the lemniscus* or *sensory decussation.* As soon as they reach the opposite side

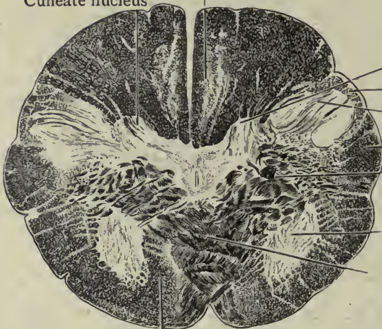


FIG. 200.—Section through the lower part of the Medulla Oblongata of the Orang.

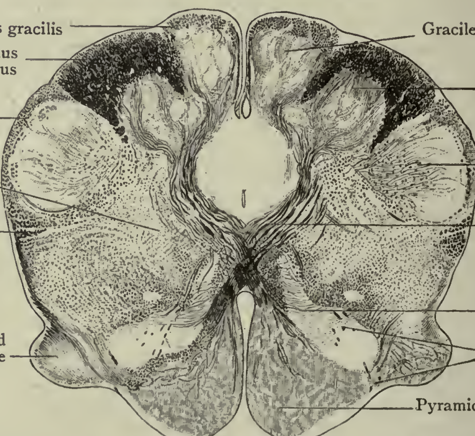


FIG. 201.—Transverse section through the lower part of the Medulla Oblongata of a full-time Fœtus, above the Decussation of the Pyramids, treated by the Weigert-Pal method. The grey matter is white, and the medullated strands of nerve fibres are black.

of the medulla oblongata the internal arcuate fibres turn upwards, and, together with the fibres of the spino-thalamic fasciculi, which are ascending from the lateral and anterior funiculi of the spinal medulla, they form a well-marked longitudinal tract called the *medial lemniscus.*

The *medial lemniscus* or *fillet* is placed close to the raphe, on the dorsal aspect of the pyramidal motor fasciculus.

The anterior column of grey matter is divided in a similar manner, by the fibres of the lateral cerebro-spinal fasciculus as it passes from the pyramid to the lateral funiculus of the opposite side of the medulla spinalis. The basal part of the divided anterior grey column remains near the central canal, but the head is displaced and forced dorso-laterally into the lateral area of the medulla oblongata, where it becomes continuous with strands of grey matter called the *nucleus ambiguus* and the *nucleus lateralis*.

Half-way up the medulla oblongata the central canal, which has been gradually approaching the dorsal surface, opens out into the cavity of the fourth ventricle, and the remains of the posterior grey columns, which surrounded it at lower levels, are spread out on the floor of the ventricle in such a manner that the portion which corresponds with the basal part of

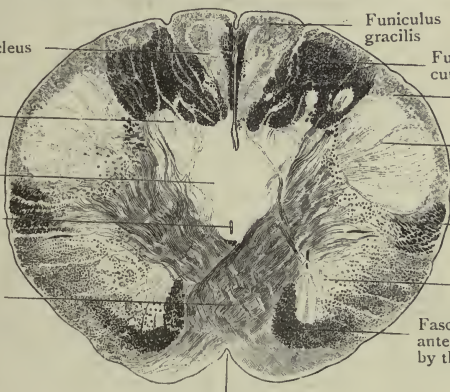


FIG. 202.—Transverse section through lower end of the Medulla Oblongata of a full-time Fœtus, treated by the Weigert-Pal method. The grey matter is therefore bleached white; whilst the medullated tracts are black.

the anterior grey column of the spinal medulla is situated close to the median plane, whilst the part which represents the base of the posterior grey column of the spinal medulla occupies a more lateral position; therefore the hypoglossal nerve, which is a motor nerve, springs from the grey matter near the median plane which is an upward prolongation of the motor or anterior grey column, and the fibres of the glosso-pharyngeal and vagus nerves, which are mainly sensory nerves, terminate in association with the more laterally situated grey matter of the medulla oblongata which is continued upwards from the base of the posterior grey column of the spinal medulla.

As the central canal opens out into the cavity of the fourth ventricle and the basal parts of the posterior grey columns are forced laterally, the ependymal epithelium of the dorsal wall of the canal is expanded into the extensive epithelial membrane, which forms the roof of the lower part of the fourth ventricle.

Every section of the upper portion of the medulla oblongata is divided into medial, lateral, and dorsal parts by the roots of the hypoglossal nerve and the roots of the vagus and glosso-pharyngeal nerves. The medial part lies between the root fibres of the hypoglossal nerve and the median raphe. It consists mainly of white matter, but on its ventral aspect, close to the anterior median fissure, lies the *nucleus of the external arcuate fibres*, embedded amongst those fibres; and on the lateral part of the dorsal aspect of the pyramidal fasciculus, there is a tract of nerve cells which is called the *medial accessory olive*.

The nerve fibres of the medial area are longitudinal, transverse and oblique. The *longitudinal fibres* form four main strands. Ventrally they form the *pyramidal fasciculus*; immediately dorsal to the pyramidal fasciculus they constitute the medial lemniscus; behind the *lemniscus* are the *tecto-spinal fibres*, and still more dorsally, immediately subjacent to the grey matter of the floor of the fourth ventricle, is the *medial longitudinal fasciculus*. The medial lemniscus consists of the fibres of the spino-thalamic fasciculi, prolonged upwards from the lateral and anterior funiculi of the spinal medulla, and of internal arcuate fibres derived from the gracile and cuneate nuclei of the opposite side. The tecto-spinal fibres are descending from the lamina quadrigemina to the spinal medulla. The medial longitudinal fasciculus is continuous, below, with the fasciculus anterior proprius of the spinal medulla. It ascends through the medulla, pons, and mid-brain to the subthalamic region, forming intimate associations with the motor nuclei of the cerebral nerves.

The *oblique* and *transverse fibres* of the medial area are internal and external arcuate fibres.

The most striking feature in transverse sections of the upper part of the lateral area of the medulla oblongata is the *olivary nucleus*, which lies subjacent to the olivary eminence. It presents the appearance of a thick undulating layer of grey matter, folded on itself so as to enclose a space filled with white matter and open towards the median plane. It is in reality a grey lamina arranged in a purse-like manner with the open mouth directed towards the raphe. Dorsal to the olivary nucleus lies the *dorsal accessory olivary nucleus*. More dorsally there are columns of nerve cells which form the *nucleus lateralis* and the *nucleus ambiguus*, and which are continuous, below, with the head of the anterior grey column of the spinal medulla. Still more dorsally is the ventral part of the nucleus of the spinal tract of the trigeminal nerve.

The white matter of the lateral area consists of longitudinal and oblique fibres, and that portion of it which lies dorsal to the olivary nucleus is sometimes spoken of as the *formatio reticularis grisea*, because it contains a certain amount of grey matter, whilst the corresponding part of the medial area, which is practically devoid of grey matter, is called the *formatio reticularis alba*.

Some of the longitudinal white fibres of the lateral area of the medulla oblongata form definite fasciculi which associate together different grey masses. Close to the surface, below the level of the olive, and immediately dorso-lateral to the issuing fila of the hypoglossal nerve lies the *bulbo-spinal fasciculus*. On the superficial aspect of the olivary nucleus and along its dorso-lateral border is the *thalamo-olivary fasciculus*, and dorsal to the thalamo-olivary fasciculus are the ventral and the dorsal spino-cerebellar fasciculi. More medially lie the rubro-spinal fasciculus and fibres of the spino-thalamic fasciculi; the oblique fibres are internal and external arcuate fibres. Some of the internal arcuate fibres are passing between the gracile and cuneate nuclei and the restiform body of the opposite side, and some are connecting the cerebellar hemisphere of one side with the olivary nucleus of the opposite side.

The dorsal area of each half of the medulla oblongata also consists of intermingled grey and white matter. The upward prolongation of the separated head of the posterior grey column forms the *nucleus of the spinal tract of the trigeminal nerve*, which lies partly in the dorsal and partly in the lateral area. Medial to it lie the upward prolongations of the nucleus gracilis and the nucleus cuneatus, and at a higher level the nuclei of the vestibular portion of the acoustic nerve. Medial to the nucleus gracilis, on the margin of the grey matter of the floor of the fourth ventricle, is the fasciculus solitarius, a strand of nerve fibres and nerve cells; the fibres being fibres of the glosso-pharyngeal and the vagus nerves passing to the cells of the strand which forms one of their nuclei.

The white fibres of the posterior area are longitudinal and oblique. The most important longitudinal fibres are—(1) the fibres of the spinal root of the trigeminal nerve which descend, close to the surface, and superficial

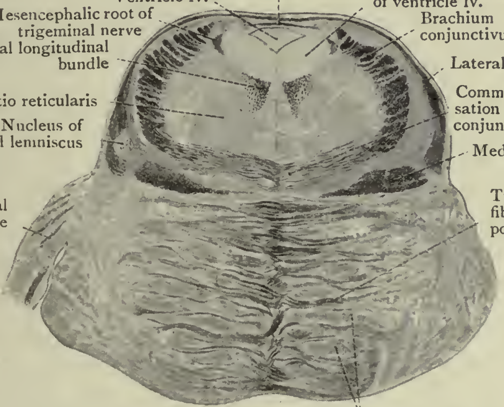


FIG. 203.—Transverse section through the upper part of the Pons of the Orang.

to the nucleus, which is formed by the upward prolongation of the head of the posterior column of grey matter; and (2) the fibres of the fasciculus solitarius (see above). The oblique fibres consist of fibres of the restiform body, fibres passing from the nucleus gracilis and nucleus cuneatus, and of fibres passing to the olivary nucleus of the opposite side.

Internal Structure of the Pons.—When transverse sections are made through the pons, it is seen to consist of two well-defined parts, viz., a ventral and a dorsal. Broadly speaking, the *ventral part*, *pars basalis*, corresponds to the pyramidal parts of the medulla oblongata, and the basal parts of the pedunculi cerebri; whilst the *dorsal part* corresponds to the formatio reticularis of the medulla oblongata and the tegmental parts of the pedunculi cerebri.

The *basilar part of the pons* is the larger of the two subdivisions. It is composed of a large number of transverse bundles of fibres, through the midst of which coarse longitudinal bundles of fibres proceed downwards from the bases of the pedunculi cerebri; some of the longitudinal fibres are cerebro-spinal fibres, passing to the medulla oblongata where they form the bundles of the pyramids. Others are cerebro-pontine fibres; they terminate round the cells of the *nuclei pontis*, which are the small masses of grey matter which occupy the interstices between the transverse and longitudinal bundles of fibres. Of the transverse fibres two distinct sets may be recognised, viz., the superficial transverse fibres, through the midst of which the bundles of cerebro-spinal fibres are prolonged, and a deeper set termed the *corpus trapezoidum*. The *superficial transverse fibres* traverse the entire thickness of the ventral part of the pons, and on each side, pass into the corresponding brachium pontis. The *trapezial fibres* lie posterior to the cerebro-spinal bundles in the boundary area between the dorsal and ventral parts of the pons, but encroach considerably into the ground of the former. They are seen only in the lower part of the pons, and they pass into the lateral lemniscus. They take origin in the terminal nucleus of the cochlear division of the acoustic nerve.

The *dorsal or tegmental part of the pons* is, for the most part, formed of a prolongation upwards of the formatio reticularis of the medulla. Superiorly, it is carried into the tegmental parts of the pedunculi cerebri. It is divided into two halves by a median raphe, which is continuous, below, with the raphe of the medulla oblongata, and, above, with the raphe of the tegmental part of the mesencephalon, whilst over its dorsal surface is spread a thick layer of grey matter which belongs to the upper part of the floor of the fourth ventricle. In transverse sections through the upper part of the pons a dark spot in the lateral part of the floor indicates the position of a small mass of pigmented cells called the *substantia ferruginea*. It underlies the locus cœruleus.

Four strands of longitudinal fibres are seen on each side in transverse sections through the dorsal part of the pons. These are—(1) the medial lemniscus, (2) the lateral lemniscus, (3) the medial longitudinal bundle, and (4) the brachium conjunctivum.

The *medial lemniscus* assumes, in the pons, a ribbon-shaped form. It is placed between the ventral part of the pons and the formatio reticularis of the dorsal part.

The *lateral lemniscus*, largely composed of fibres derived directly or indirectly from the corpus trapezoidum, is seen in the upper part of the pons. It sweeps round the lateral side of the brachium conjunctivum to gain the surface.

The *medial longitudinal bundle* is much more distinct than it is in the medulla oblongata. It has separated itself more completely from the longitudinal fibres of the formatio reticularis, and it is now seen, close to the median plane, immediately subjacent to the grey matter of the floor of the fourth ventricle.

The *brachium conjunctivum*, in transverse sections, presents a semilunar outline. It occupies a lateral position in the dorsal part of the pons, and gradually sinks deeply into its substance, although it does not become completely submerged until it reaches the mesencephalon.

The *superior olive* is a small isolated clump of grey matter which is embedded in the dorsal part of the pons in the path of the fibres of the corpus trapezoidum.

CRANIAL TOPOGRAPHY

After the gyri and sulci of the hemispheres and the various parts of the mid-brain and the hind-brain have been carefully studied the dissectors should obtain a skull which has been divided in the median sagittal plane, and should study the relationships of the various gyri and sulci of the

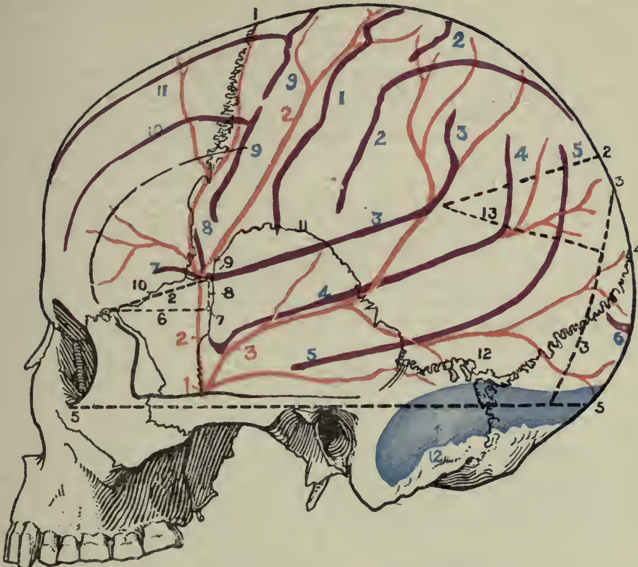


FIG. 204.—Diagram of Left Lateral Aspect of the Skull, showing the relations of the Cerebral Sulci and the Branches of the Middle Meningeal Artery to the Bones of the Cranium.

BLACK.

1. Bregma.
2. Line of lateral fissure and lateral part of parieto-occipital fissure.
3. Artificial line of separation between occipital lobe behind and the parietal and temporal lobes in front.
4. Lambda.
5. Base line.
6. Horizontal, 30 mm. long, parallel with base line.
7. Lower end of vertical line.
8. Vertical line 10 mm. long.
9. Sylvian point in region of the pterion.
10. Spheno-frontal suture.
11. Squamo-parietal suture.
12. Above asterion, where the parietal, the occipital and the mastoid portion of the temporal bone meet.
13. Artificial line of separation between the posterior parts of the parietal and temporal lobes.

BLUE.

1. Central sulcus.
2. Post central sulcus.
3. Posterior part of posterior branch of lateral fissure.
4. Superior temporal sulcus.
5. Middle temporal sulcus.
6. Posterior end of calcarine fissure.
7. Anterior horizontal branch of lateral fissure.
8. Ascending branch of lateral fissure.
9. Precentral sulcus.
10. Inferior frontal sulcus.
11. Superior frontal sulcus.

RED.

1. Stem of middle meningeal artery.
2. Anterior branch of middle meningeal artery.
3. Posterior branch of middle meningeal artery.

supero-lateral surface of each hemisphere to the bones of the cranial vault, and to the grooves for the main branches of the middle meningeal arteries, which are situated on the inner surface of the skull wall. They should note especially, in relation to the bones and the arterial grooves, the situations of the posterior horizontal limb of the lateral fissure, the central sulcus and the occipital pole of each hemisphere, because :—(1) in the lower lip of the posterior horizontal limb of the lateral fissure lies the acoustic area ; (2) the anterior central gyrus, which lies in front of the central sulcus, is the general motor area of the brain ; (3) the posterior central gyrus, which lies behind the central sulcus, is the general sensory area ; and (4) the occipital pole is in the region of the visual area (Figs. 153, 204).

The anterior branch of the middle meningeal artery lies, as a rule, over the region of the anterior central gyrus (Fig. 204), and the posterior branch, which is, however, more irregular in position, frequently runs along the ine of the first temporal gyrus, which is immediately below the posterior horizontal limb of the lateral fissure, and consequently it crosses or lies close to the acoustic area (Fig. 204).

The general positions of the sulci and gyri are shown in Figs. 135, 152, and in Fig. 38, which is a reproduction of a radiograph of a head in which metallic rods and pieces of metallic paste had been introduced, other important areas have also been made visible.

The exact positions of the various cerebral sulci vary, to a certain extent, in heads of different shapes and sizes, but a sufficiently accurate estimation, for practical purposes, can be made on any head or skull by the use of a few easily remembered points and lines (Fig. 204). They are :—

(1) A base line extending from the lower margin of the orbit to the upper border of the external acoustic meatus (5-5, black, Fig. 204).

(2) A line, 30 mm. long, extending backwards from the lower end of the zygomatic process of the frontal bone, *parallel with the base line* (6, black, Fig. 204).

(3) A line, 10 mm. long, projected upwards at right angles to (2) from its posterior end (8, black, Fig. 204). The upper end of (3) marks the "Sylvian point," which lies at or near the pterion, and it marks the position where the lateral end of the stem of the lateral fissure divides into its three terminal branches (9, black, Fig. 204).

(4) A line projected from the lower end of the zygomatic process of the frontal bone, *through the "Sylvian point,"* to the median plane (2-2, black, Fig. 204). This line usually strikes the median plane a short distance in front of the lambda ; the first 75 mm. (three inches) of it, behind the "Sylvian point," mark the position of the straight part of the posterior horizontal limb of the lateral fissure, and the last 18 mm. (about three-quarters of an inch) indicate the position of the upper and lateral part of the parieto-occipital fissure.

(5) A line marking the general position of the central sulcus. It commences 25 mm. (one inch) behind the "Sylvian point," immediately above the lateral fissure, and extends upwards and backwards to a point in the median plane situated 12.5 mm. (half an inch) behind the central point on a line extending from the root of the nose (nasion) to the external occipital protuberance (inion) (1, blue, Fig. 204).

The occipital pole of the hemisphere lies immediately above and lateral to the external occipital protuberance.

THE AUDITORY APPARATUS.

The organ of hearing admits of a very natural subdivision into three parts, viz., the external, the middle, and the internal ear.

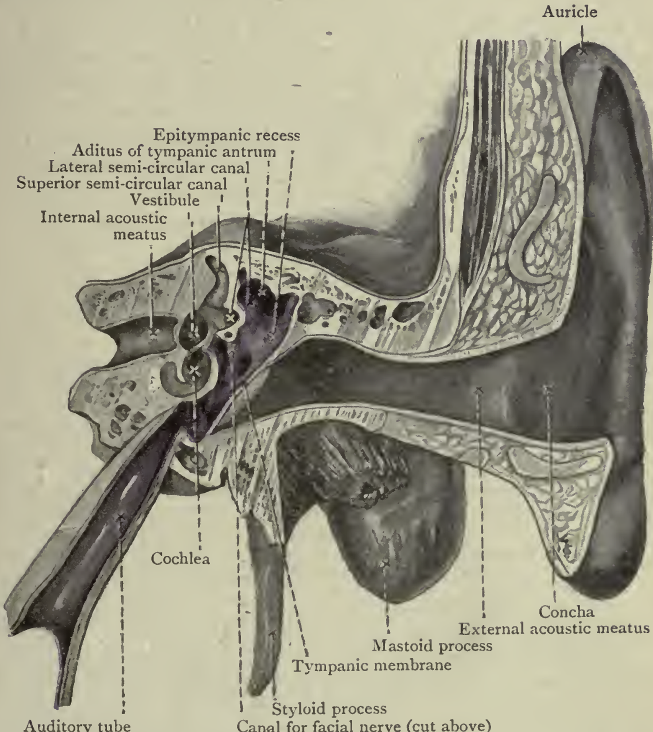


FIG. 205.—The parts of the Ear (semi-diagrammatic). The purple colour indicates the mucous lining of the tympanic cavity, which is continuous, through the auditory tube, with the mucous lining of the pharynx, and, through the aditus, with the mucous lining of the tympanic antrum.

The *external ear* consists of the auricle and the external acoustic meatus. The auricle collects the waves of sound, and is, comparatively speaking, of subsidiary importance in man, although it is of considerable service in some of the lower animals. The external acoustic meatus is a passage leading inwards, from the bottom of the concha of the auricle, to the membrana tympani, which separates the external ear from the middle ear. The *middle ear* is a narrow chamber termed the *tympanic cavity.* It is interposed between the external acoustic passage and the internal ear or labyrinth, and the main part of its lateral wall is formed by the membrana tympani. Stretching across the cavity of the tympanum, from its lateral to its medial wall, there is a chain of three small bones, called the auditory ossicles. The *internal ear*, or labyrinth, is the most essential part of the organ. It consists of a complicated system of cavities situated in the densest part of the petrous portion of the temporal bone. The cavities contain fluid called perilymph, and also a membranous counterpart of the bony chambers, called the membranous labyrinth. Within the latter there is fluid termed endolymph.

External Ear.

Dissection.—The dissection of the ear should be conducted differently on opposite sides.

On one side remove the lateral pterygoid lamina and the remains of the external and internal pterygoid muscles, if that has not been done already. Then clear away the tensor veli palatini muscle and expose the lateral surface of the auditory tube. Dissect on the postero-medial aspect of the tube and expose the levator veli palatini muscle, from the lateral side. Follow the muscle downwards and medially, below the lower orifice of the tube, into the soft palate. Then detach the auditory tube from the posterior border of the medial pterygoid lamina; cut the levator veli palatini at the point where it enters the soft palate, and separate the cartilaginous part of the auditory tube from any parts of the wall of the pharynx which may still be connected with it. When that has been done turn to the temporal bone; place the saw at right angles to the external surface of the squamous part and saw through the bone, along the line of the petro-tympanic fissure, to the posterior border of the spine of the sphenoid. Turn next to the medial surface and saw through the body of the sphenoid at the level of the anterior boundary of the foramen lacerum; then, with the aid of the chisel and bone forceps, detach the posterior border of the great wing of the sphenoid from the anterior border of the petrous part of the temporal bone. When the dissection is properly done the greater part of the temporal bone is removed from the remainder of the skull, with the cartilaginous part of the auditory tube attached to the anterior margin of its petrous portion, and a small part of the body of the sphenoid bone attached to its apex. The anterior wall of the mandibular fossa was separated by the first saw-cut, but the posterior wall is still present, with the cartilaginous part of the auditory tube attached to its medial end and the cartilaginous part of the external acoustic meatus to its lateral border. The dissector should now cut away the tragus of the auricle, to expose the orifice of the external meatus which lies at the bottom of the concha; then, with knife or scissors, he must remove the anterior wall of the cartilaginous part of the external meatus. Next pass a probe into the bony part of the meatus to gauge its length, and, whilst the probe is kept in position as a guide, cut away the anterior wall of the bony part of the meatus, taking care not to injure the tympanic membrane which closes the medial end of the meatus. When the dissection is completed the boundaries of the meatus and the lateral surface of the tympanic membrane should be examined.

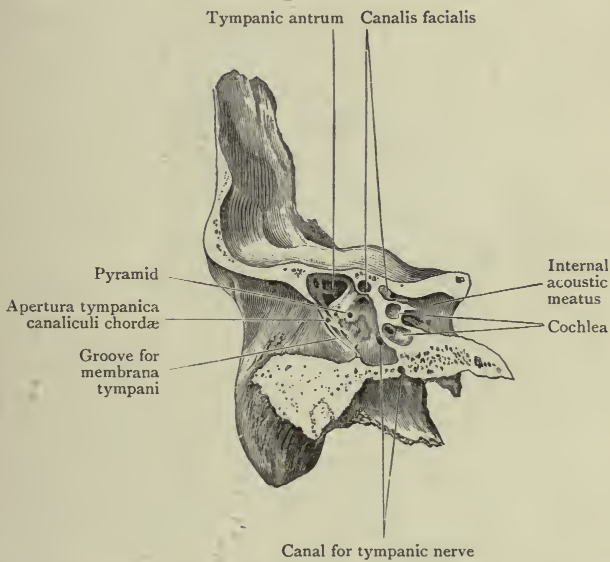


FIG. 206.—Frontal section of the Right Temporal Bone passing through the external and the internal acoustic meatuses.

Meatus Acusticus Externus.—The external acoustic meatus runs forwards and medially, from its lateral orifice to its medial boundary, and, during its course, it forms a slight curve with the convexity upwards. Its total length, measured from the bottom of the concha to the tympanic membrane, is about 24 mm., of which 8 mm. corresponds with the cartilaginous part, and 16 mm. with the bony part of the canal; but, as the membrana tympani is placed obliquely, the anterior wall and the floor are longer than the posterior wall and the roof, respectively. Moreover, the diameter of the canal is not uniform. It is narrowest at the isthmus, which lies about 5 mm. from the tympanic membrane; and its vertical diameter is greatest at the lateral end, whilst its antero-posterior diameter is greatest at its medial end. These facts must be borne in mind during the removal of foreign bodies which have made their way into the canal. As the tube passes from the surface, medially, it describes a gentle sigmoid curve, but its general direction is towards the median plane with a

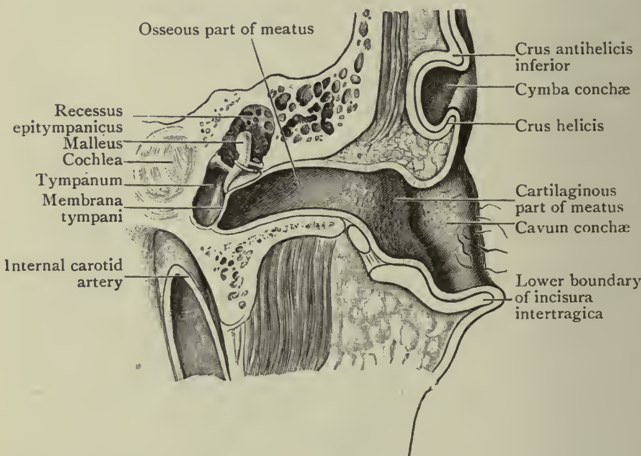


FIG. 207.—Vertical transverse section through the Right Ear: anterior half of section viewed from behind. (Howden.)

slight inclination forwards. The skin lining the cartilaginous portion is abundantly furnished with ceruminous glands and is provided also with laterally directed hairs, which tend to prevent the entrance of dust. The cutaneous lining of the osseous part, which is thin and tightly adherent to the subjacent periosteum, is destitute of hairs, and glands are for the most part absent. The cutaneous lining of the meatus is continued, in the form of an exceedingly delicate layer, over the lateral surface of the membrana tympani.

When the direction, the length, and the diameters of the external meatus have been noted, the dissectors should examine the lateral surface of the tympanic membrane.

Membrana Tympani.—The slope of the tympanic membrane has already been referred to. It slopes very obliquely downwards, forwards and medially, and its lateral surface is deeply concave. The deepest point of the concavity is the *umbo*,[1] which corresponds with the lower end of a bar of bone, *the handle of the malleus*, which is embedded in the membrane and can be seen through the thin layer of tissue covering it. The handle of the malleus extends upwards, and slightly backwards, from the umbo towards the roof of the meatus; and a short distance from the upper margin of the membrane it becomes continuous with a small laterally directed process, the *lateral process of the malleus*, which bulges the membrane towards the meatus. Above the lateral process of the malleus there is a portion of the membrane which is less tense than the remainder. It is the *membrana flaccida* (Shrapnell's membrane). It is bounded anteriorly and posteriorly by relatively thickened borders, called the *anterior* and *posterior malleolar folds.* The whole of the peripheral margin of the membrane, except that which corresponds with the membrana flaccida, is lodged in a ring-like sulcus of bone, the *sulcus tympanicus*, which is formed by the tympanic element of the temporal bone.

Dissection.—After the examination of the external meatus is completed the dissector must secure the tensor tympani muscle, which springs from the petrous part of the temporal bone, close to the apex and above the level of the cartilaginous part of the auditory tube. Having secured it, he must trace it laterally, above the auditory tube, to the point where it passes into the bony canal through which it enters the tympanum. Then he must cut away the antero-lateral wall of the cartilaginous part of the auditory tube, from the pharyngeal orifice to the upper extremity, and pass a probe through the bony part of the tube into the tympanum. He should next turn to the anterior surface of the petrous part of the temporal bone and, with chisel and bone forceps, carefully remove the tegmen tympani and expose the tympanic cavity from above. The dissection must be carried forwards into the auditory tube and backwards into the tympanic antrum. As the dissection is carried forwards a narrow margin of bone must be left along the anterior border of the tympanic membrane, and care must be taken to avoid injury to the tendon of the tensor tympani, which emerges from the extremity of its bony canal, near the medial wall of the tympanum, and crosses the cavity to be inserted into the malleus. The chorda tympani nerve, which

[1] The term "umbo" refers to a prominence and would be more properly used in association with the convexity on the inner side of the membrana tympani than with the concavity on its outer aspect.

passes forwards, close to the tympanic membrane and above the tendon of the tensor tympani, must also be preserved, if possible.

Middle Ear, Tympanic Antrum, and Auditory Tube

Cavum Tympani or Middle Ear.—The tympanic cavity is a small chamber, containing air, which is placed between the bottom of the meatus externus and the internal ear or labyrinth (Fig. 209). Posteriorly, it communicates, by a relatively large orifice, called the *aditus*, with the tympanic antrum and the mastoid air-cells; whilst, anteriorly, the auditory tube opens into it and puts it into connection with the cavity of the pharynx. It contains the chain of auditory ossicles, which crosses from its lateral to its medial wall; and it is lined with delicate mucous membrane.

The vertical depth and the antero-posterior length of the tympanic cavity are each about 12.5 mm. (*half an inch*). Its width, from side to side, is about 4.5 mm. (*a sixth of an inch*); and, as both its lateral and medial walls bulge into the cavity, its width in the centre is still further reduced. The tympanic cavity consists of—(1) an upper part, which extends upwards beyond the level of the membrana tympani, and to which the term *recessus epitympanicus* is applied (Figs. 207, 208); and (2) the *tympanum proper*, which lies immediately to the medial side of the membrana tympani. The tympanic cavity presents for examination a roof and a floor, and four walls, viz., anterior, posterior, lateral, and medial.

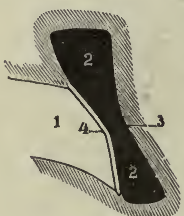


Fig. 208.—Schematic vertical section through the Tympanum. (From Testut.)

1. External meatus.
2. Tympanic cavity (the upper "2" is in the recessus epitympanicus).
3. Promontory on medial wall.
4. Membrana tympani.

The *roof* is composed of a thin plate of bone, termed the *tegmen tympani*, which separates the cavity from the middle fossa of the cranium. In chronic inflammatory conditions of the middle ear, an extension of the inflammatory process, through the tegmen, to the meninges of the brain is always to be feared.

The *floor* or *jugular wall* is narrow, and it also is formed by a thin osseous lamina, which is interposed between the tympanum and the jugular fossa. It separates the tympanum from the bulb of the internal jugular vein, and an extension of an inflammatory condition of the middle ear, through the bone to the vein, may lead to thrombosis (clotting).

FIG. 209.—The Tympanic Cavity and adjacent parts (semi-diagrammatic).

The *posterior* or *mastoid wall* presents, in its upper part, the opening or *aditus* which leads from the recessus epitympanicus into the tympanic antrum, and below that, close to the medial wall, is a small hollow conical projection termed the *pyramid* (Fig. 213). The pyramid is perforated on its summit, and the aperture leads into a canal which curves backwards and then downwards until it opens into the lower part of the last stage of the canalis facialis. The curved canal of the pyramid lodges the stapedius muscle, the delicate tendon of which enters the tympanic cavity through the aperture on the summit of the pyramid. Lateral to the pyramid is the aperture on the posterior wall called the *apertura tympanica canaliculi chordæ* through which the chorda tympani nerve enters the tympanum.

The *anterior wall* is narrow, because the medial and lateral walls converge anteriorly. The upper part of the anterior wall

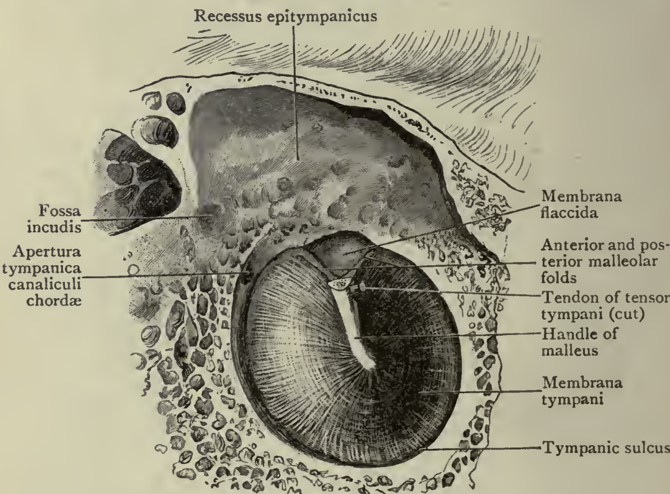


FIG. 210.—Left Membrana Tympani and Recessus Epitympanicus viewed from within. The neck and head of the malleus have been removed to show the membrana flaccida. (Howden.)

is occupied by the opening of the tensor tympani canal; the intermediate part by the tympanic orifice of the auditory tube; and the lowest part is a lamina of bone which separates the tympanic cavity from the carotid canal. The tympanic end of the septum between the auditory tube and the tensor tympani canal is called the *processus cochleariformis*; it serves as a pulley round which the tendon of the tensor tympani muscle turns abruptly, in a lateral direction, towards the malleus.

On the *medial wall*, which intervenes between the tympanum and the labyrinth, there are eminences, depressions, and apertures which require notice. The anterior, and larger, part of the wall bulges laterally, into the cavity (Figs. 209, 213), and forms a very evident elevation, termed the *promontory*. Above the posterior part of the promontory there is a depression called the fossa of the fenestra vestibuli; and at the bottom of the fossa is an oval aperture called the *fenestra vestibuli* (Fig. 213). The long axis of the fenestra is directed antero-posteriorly, and, in the macerated bone, the aperture opens into the vestibular part of the labyrinth,

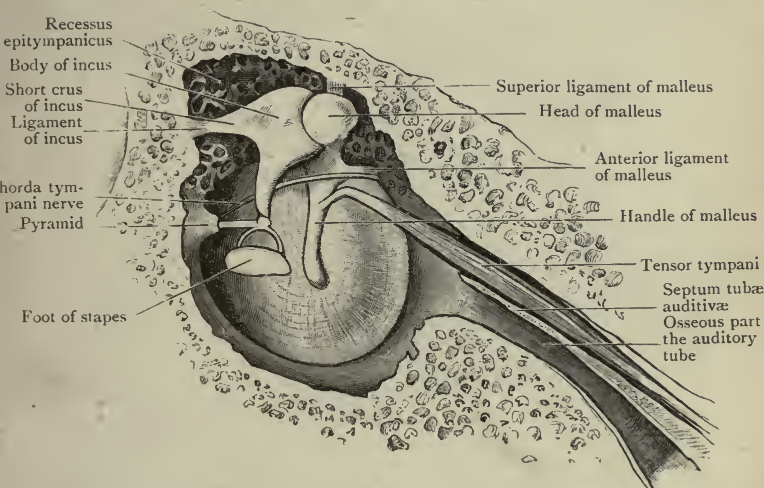


FIG. 211.—Left Membrana Tympani and Chain of Tympanic Ossicles seen from the medial aspect. (Howden.)

but, in the recent state, it is closed by the footpiece of the stapes (Fig. 209), the most medial of the auditory ossicles, which is implanted in the fenestra. The pyramid, on the posterior wall, is immediately posterior to the fenestra vestibuli. Above the fenestra vestibuli, in the angle formed by the meeting of the roof and medial wall of the tympanum, and therefore in the recessus epitympanicus, is an antero-posterior ridge. It is produced by the canalis facialis bulging into the tympanum (Fig. 213). The wall of the canal is very thin, and allows the white facial nerve, which is contained within the canal, to be readily seen. Below and behind the promontory is the fossula fenestræ cochleæ, and at the bottom of the fossa there is an aperture called the *fenestra cochleæ*; in the macerated bone the aperture leads into the cavity of the cochlea, but, in the recent state, it is closed by a membrane called the *secondary membrane of the tympanum.*

The *lateral wall* of the tympanic cavity is formed, for the most part, by the membrana tympani, but, above the tympanic membrane, the lateral wall of the recessus epitympanicus is formed by a portion of the squamous part of the temporal bone (Figs. 209, 210).

Membrana Tympani.—The membrana tympani is an elliptical disc of membrane which is stretched across the

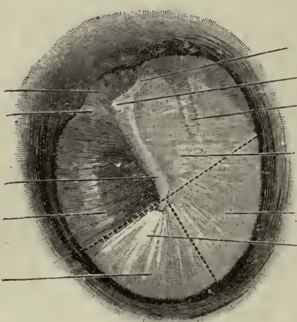


FIG. 212.—Left Tympanic Membrane as viewed from the external meatus during an otoscopic examination. The dotted lines indicate the manner in which the tympanic membrane is subdivided arbitrarily into four areas or quadrants. (Howden.)

medial end of the meatus acusticus externus, and it forms the greater part of the lateral wall of the tympanum. It is placed very obliquely; its lower and its anterior borders both inclining medially.

The mode of attachment of the membrane deserves some attention. At the medial end of the meatus a ring-like ridge of bone, very distinctly grooved, forms a frame in which the membrane is set (Fig. 210). But the ridge is deficient above, where its extremities are separated by a deep notch called the *incisura tympanica.* The notch is occupied by a portion of the membrane which is not so dense in its texture (seeing that the fibrous layer is absent), and not so tightly stretched as the remainder; consequently it receives the name of the *membrana flaccida* (Shrapnell's membrane). The circular groove in the bony ridge is called the *sulcus tympanicus.* The edge of that part of the membrane which is fixed in the sulcus tympanicus is thickened, and at the incisura tympanica, the thickened part, it is carried down, anterior and posterior to the membrana flaccida, in the form of two bands, called respectively the *anterior* and *posterior malleolar folds.*

The membrana tympani is composed of three layers—viz., a lateral cuticular layer, an intermediate fibrous lamina, and

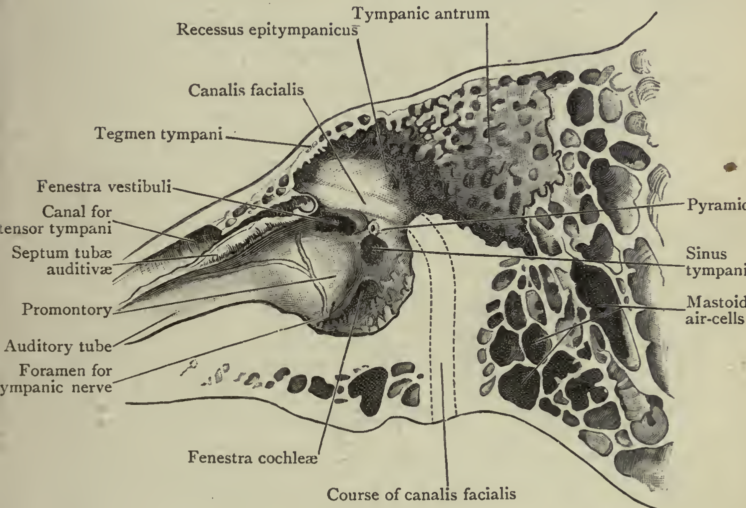


FIG. 213.—Vertical section through the Left Ear : postero-medial half of section viewed from the front. (Howden.)

a medial mucous layer. The handle of the malleus is intimately connected with the fibrous layer, and is covered medially by the mucous layer. It draws the membrane towards the tympanic cavity, and is the cause of the concavity on the lateral surface. The deepest point of that concavity corresponds with the flattened extremity of the handle of the malleus, and is termed the *umbo.*

When the living ear is examined, with a speculum, the surface of the membrane appears highly polished, and a cone of light extends downwards and forwards from the tip of the handle of the malleus. A pair of striæ (Prussak's striæ), which correspond to the anterior and posterior malleolar folds, extend from the processus lateralis of the malleus to the margins of the incisura tympanica, and thus map out the membrana flaccida. The long crus of the incus can be faintly seen through the membrana tympani, parallel with and posterior to the handle of the malleus.

Antrum Tympanicum.—The tympanic antrum is a recess or air-chamber, in the temporal bone. It lies immediately behind the epitympanic portion of the tympanic cavity and, in the adult, it is 14 mm. (*about half an inch*) from the surface of the skull, medial to the suprameatal triangle. In the child it is much more superficial.

The cavity of the tympanic antrum is lined with mucous membrane which is continuous, anteriorly, through a relatively wide aperture called the *aditus*, with the mucous membrane of the tympanic cavity, and it is also continuous, posteriorly and below, with the mucous membrane of the air-cells in the mastoid portion of the temporal bone.

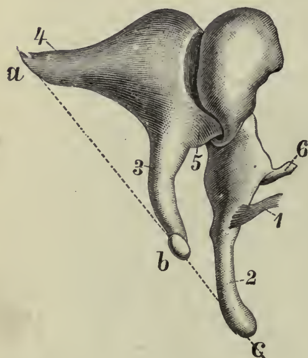


FIG. 214.—Left Malleus and Incus. (After Helmholtz.)

1. Tendon of tensor tympani.
2. Handle of the malleus.
3. Long crus of the incus.
4. Short crus of the incus.
5. Incus.
6. Anterior process of the malleus. The straight line *a b c* connects the extremities of the two crura of the incus with the extremity of the manubrium of the malleus.

The *roof* of the tympanic antrum is formed by a thin plate of the petrous part of the temporal bone, called the *tegmen tympani*. It separates the tympanic antrum from the cavity of the middle fossa of the skull and from the membranes covering the inferior surface of the temporal lobe of the brain. The *lateral wall* is formed by that portion of the squamous part of the temporal bone which lies immediately above and behind the aperture of the external acoustic meatus. The *posterior wall* and the *floor* are formed by the mastoid portion of the temporal bone, and it is through apertures in those boundaries that the cavity of the tympanic antrum communicates with the mastoid air-cells. On the *medial wall*, which is formed by the petrous part of the temporal bone, is a horizontal bulging, caused by the lateral semicircular canal of the internal ear; the bulging extends forwards into the aditus (Fig. 205). Immediately anterior to the medial margin of the aditus the canalis facialis descends along the posterior border of the medial wall of the tympanum.

The antero-posterior diameter of the tympanic antrum is about 14 mm., the vertical diameter, about 9 mm., and the transverse diameter, about 7 mm.

Tympanic Mucous Membrane.—The tympanum is lined, throughout, with a thin mucous membrane which is continuous with the mucous membrane of the pharynx, through the auditory tube. As already mentioned, it forms the medial layer of the membrana tympani, and it is prolonged posteriorly into the tympanic antrum and mastoid air-cells. It covers the ossicles also, and it invests the tendons of the stapedius and tensor tympani muscles.

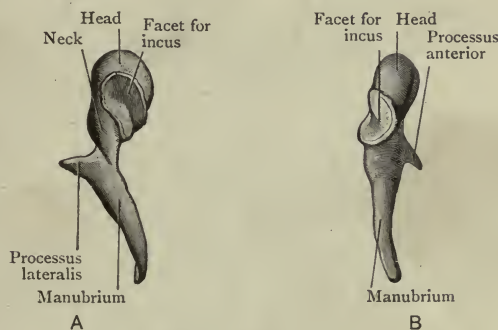


FIG. 215.—The Left Malleus. (Howden.)

A. Posterior aspect. B. Medial aspect.

Ossicula Auditus.—The auditory ossicles are the malleus, the incus, and the stapes.

The *malleus* presents a head, a neck, a manubrium, and two processes termed the processus lateralis and the processus anterior. The *head* is large and rounded. It is directed upwards, and lies above the level of the membrana tympani, in the recessus epitympanicus, close to the roof and the lateral wall of the tympanum (Figs. 209, 211). On its posterior aspect there is a notch-like articular surface, for articulation with the body of the incus. The *manubrium* is attached to the fibrous layer of the membrana tympani. The *processus lateralis* (O.T. *brevis*) is a stunted projection which springs from the root of the manubrium. It is directed laterally, and abuts against the membrana tympani immediately below the membrana flaccida. The *processus anterior* (O.T. *gracilis*) is a slender spicule of bone which passes forwards and downwards into the petro-tympanic fissure. It almost invariably breaks when the malleus is detached from the adult skull, but it can be easily preserved in the skull of an infant.

The *incus* is shaped somewhat like a præmolar tooth in which the roots are very divergent. It presents a body and a long and a short crus. The *body* is provided with an articular surface, which looks forwards and articulates with the head of the malleus. The *short crus* is directed backwards, and its extremity is attached, by ligaments, to the posterior wall of the tympanum, below the opening into the tympanic antrum. The *long crus* proceeds downwards and medially, in a direction nearly parallel

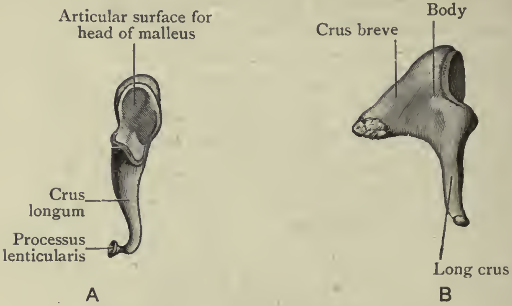


FIG. 216.—The Left Incus. (Howden.)

A. Anterior aspect. B. Medial aspect.

to that of the manubrium of the malleus, but more medial, and on a plane posterior to the manubrium. On its inferior extremity, which is bent medially, there is a small knob of bone, called the *processus lenticularis*, which articulates with the head of the stapes.

The malleus and incus move together on an axis which is formed by the processus anterior of the malleus and the crus breve of the incus. The articular surfaces of the two bones are provided with peculiar catch-teeth which interlock when the bones are performing their ordinary movements. When, however, force is applied to the medial surface of the membrana tympani, as, for instance, when the tympanum is inflated through the auditory tube, the incudo-malleolar joint gapes and the malleus moves by itself. Traction upon the attachments of the stapes, through the incus, is thus avoided.

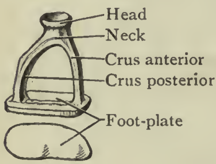


FIG. 217.—Left Stapes. (Howden.)

The *stapes* is shaped like a stirrup, and presents a head or lateral extremity separated by a slightly constricted *neck* from two crura which join a medial plate called the basis stapedis. The *head* is excavated by an articular cup for the processus lenticularis of the incus. The *crura* are grooved longitudinally on their concave sides (sulcus stapedis). The posterior crus is more sharply curved than the anterior crus. The *base* fits into the fenestra vestibuli and corresponds in its outline with that aperture. Its lower border is straight, whilst its upper border is curved.

Ligaments of the Auditory Ossicles.—In addition to the delicate articular capsules, which surround the joints between the auditory ossicles, there are certain bands which connect the bones to the walls of the tympanum and serve to restrain their movements.

In connection with the malleus there are—(1) an *anterior ligament*, which passes forwards, from the root of the processus anterior, to the anterior wall of the tympanum in the neighbourhood of the petro-tympanic fissure; (2) a *lateral ligament*, which extends from its lateral process to the margin of the incisura tympanica; and (3) a *superior ligament*, which connects the head with the roof of the tympanum.

The *ligament of the incus* binds the extremity of its short crus to the posterior wall of the tympanum, whilst the *annular ligament of the stapes* connects the margin of its base to the circumference of the fenestra vestibuli.

Tympanic Muscles.—Two muscles are associated with the tympanum, viz., the stapedius and the tensor tympani.

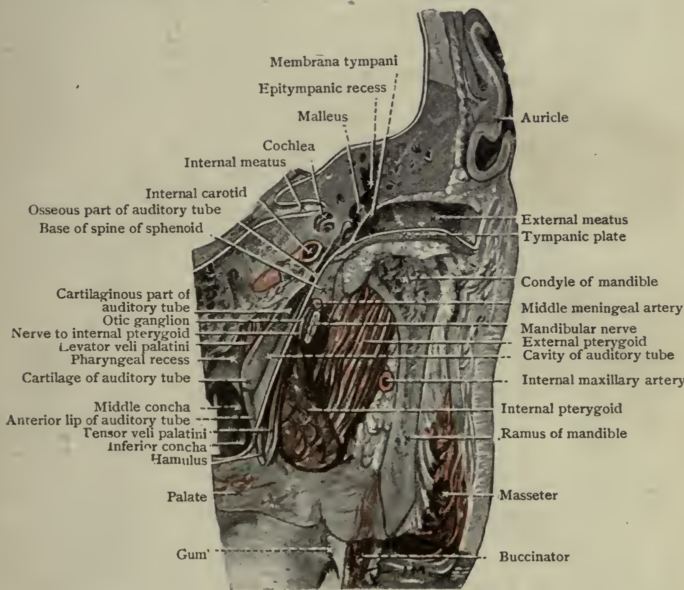


FIG. 218.—Oblique section of a part of the Head showing the relations of the Auditory Tube.

The *stapedius* occupies the interior of the pyramid and the canal which curves downwards from it. The delicate tendon of the stapedius enters the tympanum, through the aperture on the summit of the pyramid, and is inserted into the posterior aspect of the neck of the stapes. The stapedius muscle is supplied by a branch from the *facial nerve.*

The *tensor tympani* arises from the upper part of the cartilage of the auditory tube and from the contiguous parts of the great wing of the sphenoid and the petrous part of the temporal bone. From its origin it passes backwards and laterally, above the osseous part of the auditory tube. In the tympanic cavity the tendon turns at right angles, round the extremity of the processus cochleariformis (p. 512), and passes laterally, towards the lateral wall of the tympanum, to its insertion into the upper part of the medial surface of the manubrium of the malleus. The tensor tympani receives its nerve of supply through the *otic ganglion* from the mandibular division of the trigeminal nerve. The name of the muscle indicates its action.

Chorda Tympani Nerve.—The chorda tympani, which traverses the tympanic cavity in close relation to the upper part of the membrana tympani, is described on p. 182.

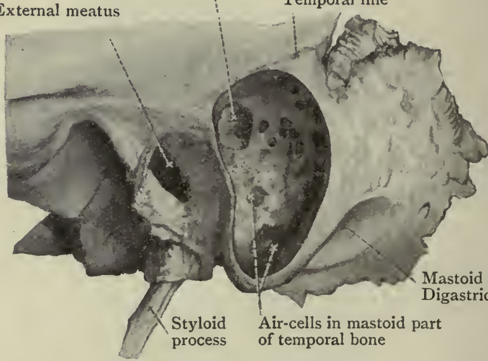


FIG. 219.—Dissection of the Tympanic Antrum and the mastoid part of the temporal bone from the outer side.

Tympanic Plexus.—This has been described previously on p. 220.

Tuba Auditiva (O.T. **Eustachian**).—The auditory tube is the passage which places the tympanic cavity in communication with the pharynx. Through it air reaches the tympanic cavity and antrum and the mastoid cells. It consists of an osseous and a cartilaginous portion. The *osseous portion* is about 12.5 mm. (*half an inch*) in length. It is widest at its entrance into the tympanum, and narrowest at its other end. The *cartilaginous portion* is about an inch in length, and has been already described on p. 298.

Dissection : Second Method.—On the opposite side the bony part of the external meatus, the tympanic antrum, and the tympanic cavity should be approached from the postero-lateral aspect. The dissection of the bone should be carried out after the manner adopted by the surgeon when operating for the cure of extensive mastoid and middle ear disease, but, to facilitate the dissection, and to gain better access to the bone, the auricle may be removed by cutting through the cartilaginous part of the external meatus.

After the auricle has been cut away take all the soft parts, including the periosteum, from the outer surface of the mastoid part of the temporal bone, and identify—(1) the supra-meatal triangle and the supra-meatal spine, which lie at the junction of the superior with the posterior border of the bony part of the external meatus, and (2) the temporal line, which passes, backwards and upwards, above the supra-meatal triangle. The

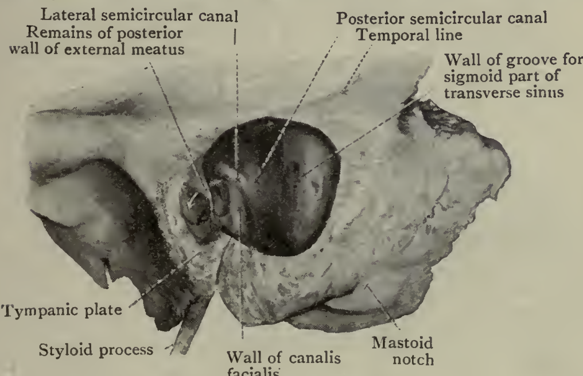


FIG. 220.—Dissection of the Tympanic Antrum and the petro-mastoid part of the temporal bone from the outer side. The arrow is passing through the aditus from the tympanic antrum into the tympanic cavity.

objects of the first stage of the dissection are—(1) the removal of the outer compact layer of bone; (2) the opening up of the spongy tissue of the mastoid part of the temporal bone, and the exposure of the mastoid air-cells and the cavity of the tympanic antrum, whilst, at the same time, injury to the posterior wall of the bony part of the external meatus and to the sigmoid part of the transverse sinus, which lies in a groove on the inner aspect of the posterior part of the mastoid portion of the temporal bone, is avoided. The tympanic antrum lies at the level of the supra-meatal triangle, that is, above and posterior to the external meatus, and about 14 mm. (*a little more than half an inch*) from the superficial surface of the temporal bone. The dissection should be commenced in the supra-meatal triangle, and should be carried, forwards and medially, into the bone, parallel with the posterior wall of the external meatus, until the tympanic antrum is opened into. After the tympanic antrum has been identified, the spongy tissue of the anterior part of the mastoid area must be gradually removed till the more medially situated and more compact bone is exposed. When that stage of the dissection is completed, the dissector should note the following points :—(1) In the anterior boundary of the exposed area is the compact posterior wall of the bony part of the external meatus. (2) Posteriorly is a broad projecting ridge indicating the position of the groove which lodges the sigmoid part of the transverse sinus. (3) At the upper and deeper part of the area are the medial wall of the tympanic antrum and the aditus leading into the tympanic cavity. (4) The intervening area is occupied by the remains of the mastoid air-cells, which may extend downwards to the tip of the mastoid process. They are continuous above with the cavity of the tympanic antrum. (5) On the medial wall of the aditus and the anterior part of the medial wall of the tympanic antrum is a horizontal ridge which

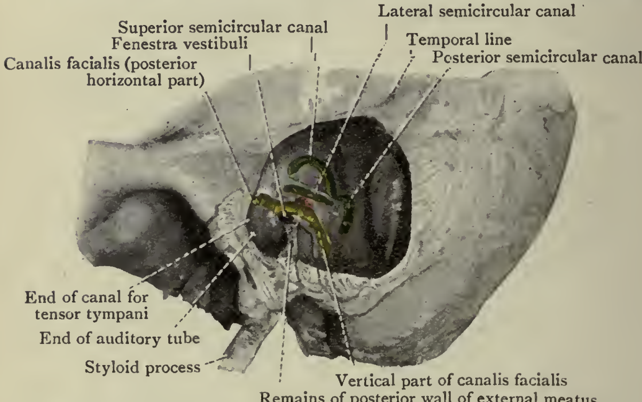


FIG. 221.—Dissection of the Tympanic Cavity and the semicircular canals from the outer side.

indicates the position of the lateral semicircular canal of the labyrinth, and, below it, on the medial wall of the mouth of the aditus, is a vertical ridge indicating the position of the canalis facialis, which lodges the important facial nerve.

The next stage of the dissection consists in the removal of the posterior wall of the external meatus, and the exposure of the lateral surface of the tympanic membrane (p. 514). After the tympanic membrane has been examined, a seeker should be passed through the aditus into the tympanic cavity, and its handle should be allowed to rest on the lower part of the exposed area ; then, whilst the seeker remains in position, the remainder of the posterior wall and the upper boundary of the external meatus, from the level of the seeker to the level of the roof of the tympanic antrum, can be cut away without fear of injury to any important structure. The dissection should be completed by the removal of the tympanic membrane and ossicles, and when this has been done a very complete view will be obtained of the medial walls of the tympanic cavity, the aditus, and the tympanic antrum. Anteriorly, on the medial wall of the tympanic cavity, is the promontory, which marks the position of the first turn of the cochlea. Above and posterior to the promontory is the fenestra vestibuli. The fenestra cochleæ lies at the lower and posterior part of the promontory, in the anterior part of a recess called the fossula fenestræ cochleæ. Above the fenestra vestibuli is a ridge caused by the posterior horizontal part of the canalis facialis; this becomes continuous, on the medial wall of the aditus, with the vertical ridge which indicates the position of the vertical part of the canal. Above the latter is the horizontal ridge due to the lateral semicircular canal. The dissector should open the canalis facialis to expose the facial nerve; then he should open the lateral semicircular canal, and afterwards remove the bone above and posterior to it to expose the walls of the superior and posterior semicircular canals (Figs. 219, 220, 221).

Intrapetrous Part of the Facial Nerve and the Acoustic Nerve.

The facial and acoustic nerves have already been traced into the internal acoustic meatus (p. 112). The dissector should now open up the meatus and follow the facial nerve in its course through the petrous portion of the temporal bone. The canal which it occupies is termed the *canalis facialis* (O.T. *aqueduct of Fallopius*). It begins at the bottom of the internal acoustic meatus, and opens on the exterior of the skull at the stylo-mastoid foramen. Between its commencement and termination it pursues a curved course, and that, combined with the density of the bone, renders the dissection difficult.

Dissection.—On the side on which the middle ear has been opened from the lateral aspect and the canalis facialis has already been partially opened up, the dissector should complete the dissection of the intrapetrous part of the facial nerve and should examine the acoustic nerve.

Separate the temporal bone from the other cranial bones which still adhere to it, and fix it in the natural position (in a vice if possible). Remove the squamous portion by a horizontal saw cut at the level of the anterior surface of the petrous portion. Make a second horizontal saw cut, immediately above the roof of the internal acoustic meatus, and carry it laterally into the tympanum, in which it should emerge immediately above the already opened canalis facialis where the latter lies above the fenestra vestibuli. Then, with the bone forceps or chisel, remove the remains of the roof of the internal meatus and follow the facial nerve along the canalis facialis to the hiatus canalis facialis, and so expose the ganglion geniculi. Secure the

branches which arise from the ganglion and then follow the nerve backwards above the fenestra vestibuli. The greater part of the vertical portion of the canal has already been opened from the lateral aspect; the remainder can now be displayed by means of two saw cuts—(1) a frontal section (vertical transverse) carried medially from the lateral surface of the bone to the posterior border of the stylo-mastoid foramen; (2) a sagittal cut (vertical antero-posterior) carried from the posterior surface of the bone to meet cut (1). The portion of bone between the two cuts must then be removed, and the dissection must be completed with bone forceps. Three branches are given off from the facial nerve in the terminal part of the canal.

Intrapetrous Portion of the Facial Nerve.—As the facial nerve traverses the petrous bone, it may be looked upon as consisting of four parts, which differ from one another in the relations they present and in the direction which they take. They are:—

1. A part within the internal acoustic meatus.
2. A very short part which extends from the bottom of the internal acoustic meatus to the ganglion geniculi.
3. A part which occupies that portion of the canalis facialis which runs along the medial wall of the tympanic cavity.
4. A part which extends vertically downwards to the stylo-mastoid foramen.

First Part.—In the internal acoustic meatus, the facial nerve runs almost directly laterally, in company with the acoustic nerve. In that stage of its course it lies in relation to the upper and anterior part of the acoustic nerve, and its motor and sensory roots join. At the bottom of the internal acoustic meatus it enters the canalis facialis.

Second Part.—The second part of the facial nerve is very short. It runs laterally, with a slight inclination forwards between the vestibule and cochlea, and very soon ends in the swelling termed the *ganglion geniculi*.

Third Part.—At the ganglion geniculi, the facial nerve bends suddenly and proceeds backwards and slightly downwards, in that portion of the canal which runs along the upper part of the medial wall of the tympanic cavity, immediately above the fenestra vestibuli (O.T. ovalis).

The first three portions of the facial nerve are nearly horizontal, and pursue a somewhat V-shaped course. The apex of the V is directed forwards, and corresponds to the ganglion geniculi.

Fourth Part.—The fourth part is vertical, and passes downwards, posterior to the pyramid, to gain the stylo-mastoid foramen.

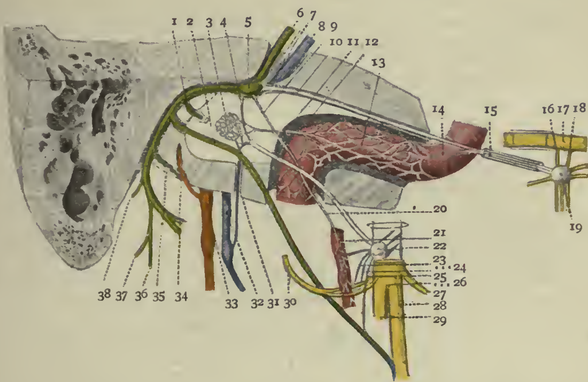


FIG. 222.—Diagram of Intrapetrous part of facial nerve and its connections. (Prof. A. M. Paterson.)

1. Nerve to stapedius.
2. Chorda tympani.
3. Tympanic plexus.
4. Communication to lesser superficial petrosal nerve.
5. Ganglion geniculi.
6. Motor part of facial nerve.
7. Sensory part of facial nerve.
8. Acoustic nerve.
9. External petrosal nerve.
10. Greater superficial petrosal nerve.
11. Carotid canal.
12. Carotico-tympanic branch.
13. Carotid plexus.
14. Great deep petrosal.
15. Nerve of pterygoid canal.
16 and 18. Spheno-palatine branches.
17. Maxillary nerve.
19. Spheno-palatine ganglion.
20. External petrosal nerve.
21. Middle meningeal artery.
22. Otic ganglion.
23 and 24. Branches to auriculo-temporal nerve.
25. Communication to chorda tympani.
26. Posterior division of mandibular nerve.
27. Anterior division of mandibular nerve.
28. Lingual nerve.
29. Inferior alveolar nerve.
30. Auriculo-temporal nerve.
31. Tympanic branch of glosso-pharyngeal.
32. Glosso-pharyngeal nerve.
33. Vagus.
34. Auricular branch of vagus.
35. Communication from facial to auricular branch of vagus.
36. Nerve to digastric (post. belly).
37. Nerve to stylo-hyoid muscle.
38. Posterior auricular nerve.

The *branches* which spring from or join the facial nerve during its passage through the temporal bone are:—

1. The greater superficial petrosal nerve,
2. Communicating twig to the lesser superficial petrosal,
3. External superficial petrosal nerve,

$\Big\}$ from ganglion geniculi.

4. Nerve to stapedius.
5. Chorda tympani.
6. Communicating twigs to the auricular branch of vagus.

The *greater superficial petrosal nerve* has been examined already (p. 241). Its origin from the ganglion geniculi of the facial nerve can now be seen.

The *communicating branch* to the lesser superficial petrosal arises from the ganglion geniculi, and unites with the fibres of the tympanic nerve which issue from the tympanic plexus.

The *external petrosal nerve* is not always present. It joins the sympathetic plexus which accompanies the middle meningeal artery.

The *nerve to the stapedius muscle* arises from the facial as it passes downwards posterior to the pyramid. It enters the base of the pyramid and thus reaches the stapedius muscle.

The *communicating twigs to the auricular branch* of the vagus arise a short distance above the stylo-mastoid foramen.

Chorda Tympani.—The chorda tympani represents to a large extent the sensory fibres set free from the trunk of the facial nerve. It is the largest branch given off by the facial during its passage through the *canalis facialis.* It takes origin a short distance above the stylo-mastoid foramen, and arching upwards and forwards, in a narrow canal in the petrous portion of the temporal bone (the canaliculus chordæ tympani), it appears in the tympanum by passing through the tympanic aperture of the canaliculus chordæ, below the base of the pyramid, and close to the posterior margin of membrana tympani. The bony tunnel which it occupies can easily be opened up in a decalcified bone, but is somewhat difficult to expose in the hard bone. After entering the tympanum the chorda tympani runs forwards, upon the upper part of the membrana tympani, under cover of the mucous layer. It crosses the handle of the malleus on the medial aspect near its root. Finally, reaching the anterior end of the tympanic cavity it crosses the anterior process (O.T. gracilis) of the malleus, passes above the tensor tympani, and traverses the medial end of the petro-tympanic fissure, which conducts it to the exterior of the skull. From its exit to its junction with the lingual nerve the chorda tympani has already been traced (p. 182).

Nervus Acusticus.—In the internal acoustic meatus the acoustic nerve lies at a lower level than the facial, and at the bottom of the passage it splits into two parts, termed the *cochlear* and *vestibular divisions.* The two divisions again subdivide and supply the different parts of the labyrinth of the ear through the foramina of the lamina cribrosa (Fig. 209).

Internal Ear.

Dissection.—After the examination of the intrapetrous part of the facial nerve and the acoustic nerve is completed the dissector should display the labyrinth of the internal ear by means of two saw cuts—(1) an antero-posterior vertical cut, carried from the upper surface of the bone downwards to the floor of the tympanum, along the junction of its medial and posterior boundaries; (2) a horizontal cut. This cut should be commenced at the apex of the petrous part of the temporal bone and should be carried laterally till it joins the vertical cut, posteriorly, and enters the tympanic cavity, anteriorly, at the level of the mid-height of the promontory. When the upper part of the petrous portion of the temporal bone, separated by the two cuts, is removed, the vestibular and cochlear parts of the labyrinth and portions of the semicircular canals will be displayed. The dissector should demonstrate the positions and curves of the semicircular canals and the canalis facialis by passing bristles through them.

Auris Interna.—The internal ear or labyrinth consists of an intricate system of cavities in the petrous part of the temporal bone, called the *osseous labyrinth*, and a series of hollow membranous structures, connected with the filaments of the acoustic nerve, which lie in the osseous labyrinth and constitute the *membranous labyrinth.*

The *osseous labyrinth* is composed of a chamber termed the vestibule, posterior to which are placed the three semicircular canals, whilst anteriorly is the cochlea. All the cavities communicate with one another. The corresponding membranous parts do not completely occupy the osseous chambers, and the intervening space is filled with a fluid termed the *perilymph.* The *membranous labyrinth* also contains a fluid which receives the name of *endolymph.*

Vestibulum.—The vestibule is a small bony chamber of ovoid form, which possesses an antero-posterior diameter of about 4 mm. (*one-sixth of an inch*). It is situated between the medial wall of the tympanum and the bottom of the internal acoustic meatus.

Into the posterior part of the vestibule the three semicircular canals open by *five round apertures*; whilst in its lower and anterior part is the opening of the *scala vestibuli* of the cochlea.

On the *lateral wall* is the fenestra vestibuli, which is closed, in the recent state, by the delicate periosteal lining of the chamber and by the base of the stapes. When those parts are removed, the vestibule communicates directly with the tympanum. In the anterior part of the *medial wall* of the vestibule there is a circular depression, termed the *recessus sphæricus*; it is bounded posteriorly by a vertical ridge, called the *crista vestibuli*. In the bottom of the recessus sphæricus are some minute holes through which pass filaments from the acoustic nerve. In the *roof* of the vestibule is another depression, named the *recessus ellipticus*. It is placed posterior to the crista vestibuli.

A small aperture in the posterior part of the medial wall also deserves mention. It is the mouth of the *aquæductus vestibuli*—a small canal which passes backwards to

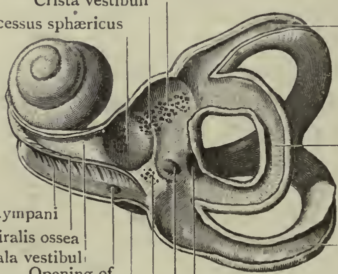


FIG. 223.—Interior of the Left Bony Labyrinth viewed from the lateral aspect. (Howden.)

the posterior surface of the petrous part of the temporal bone, where it opens under the dura mater.

Canales Semicirculares Ossei.—There are three bony semicircular canals or tubes placed posterior to the vestibule. They are bent upon themselves, so that each forms considerably more than half a circle, and they occupy planes at right angles to each other like three faces of a cube. They are termed superior, posterior, and lateral, and they open into the posterior part of the vestibule by five round orifices, the number of openings being reduced to five because the adjoining extremities of the superior and posterior canals are fused into a common canal called the *crus commune*, which opens by a single orifice. One extremity of each canal where it joins the vestibule becomes expanded into what is termed its *ampulla*. There are, therefore, three ampullated ends.

The *superior semicircular canal* forms the highest part of the labyrinth. Its highest part lies beneath the eminentia arcuata on the anterior surface of the petrous part of the temporal bone. It is placed vertically, and is almost transverse to the long axis of the petrous part of the temporal bone. The *posterior semicircular canal*, which is the longest of the three tubes, is also vertical, and lies in a plane parallel to the posterior surface of the petrous part of the temporal bone. The *lateral semicircular canal* is the shortest of the

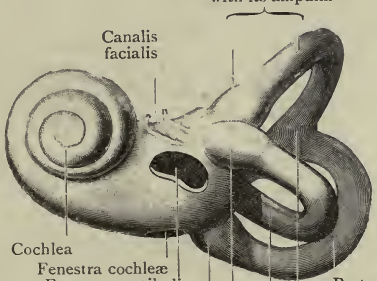


FIG. 224.—Left Bony Labyrinth viewed from lateral side. (Howden.)

tubes. It lies in a horizontal plane, in the angle between the superior and posterior canals.

Cochlea.—The cochlea is a tapering tube which is coiled spirally, for two turns and a half, around a central pillar, termed the *modiolus*. The appearance produced is somewhat similar to that of a spiral shell. The cochlea lies anterior to the vestibule; its base is directed towards the bottom of the internal acoustic meatus; its long axis runs antero-laterally from the base, and its apex lies in close relation with the canal for the tensor tympani muscle.

The cochlear tube rapidly diminishes in diameter as it is traced towards the apex of the cochlea. Its closed extremity is termed the *cupola*. The first turn which the cochlea takes around the modiolus produces the bulging on the medial wall of the tympanum which has been described under the name of the promontory (Figs. 223, 209).

The *modiolus* is thick at the base, but rapidly tapers towards the apex. Its base abuts against the bottom of the internal acoustic meatus. It forms the inner wall of the cochlear tube, and winding spirally round it, like the thread of a screw, is a thin lamina of bone, termed the *lamina spiralis*, which partially subdivides the osseous tube into two passages.

Numerous minute canals traverse the modiolus, and one more conspicuous than the others, called the *longitudinal canal of the modiolus*, extends along its centre. The spiral lamina also is tunnelled by small canals in communication with those in the modiolus, whilst one, the *spiral canal of the modiolus*, winds spirally around the central pillar in the attached margin of the spiral lamina. All these channels convey filaments from the cochlear division of the acoustic nerve to the membranous cochlea, whilst the spiral canal lodges the *ganglion spirale cochleæ*, which is the peripheral ganglion of the cochlear part of the acoustic nerve.

The *membranous cochlear tube* or *ductus cochlearis* is placed between the free margin of the spiral lamina and the opposite side of the wall of the cochlear tube. It completes the subdivision of the bony cochlea into two compartments, which are termed the scala tympani and the scala vestibuli. The *scala tympani* is the larger of the two. It begins at the fenestra cochleæ, where the secondary membrane of the tympanum shuts it off from the tympanic cavity. At the apex of the cochlea it communicates with the scala vestibuli by means of an aperture termed the *helicotrema*. At the base of the cochlea the *scala vestibuli* communicates with the lower and anterior part of the vestibule. The perilymph therefore, in the semicircular canals and vestibule, is directly continuous with that in the scala vestibuli and scala tympani.

It can now be understood how vibrations of the membrana tympani are communicated to the perilymph within the osseous labyrinth. The chain of auditory ossicles, through the base of the stapes, affects the perilymph in the vestibule. The vibrations of the perilymph passing along the scala vestibuli into the scala tympani affect in turn the secondary membrane of the tympanum, which is stretched across the fenestra cochleæ. With every inward movement of the membrana tympani and of the base of the stapes, there is an outward movement of the membrane of the fenestra cochleæ, and *vice versa*. The vibrations of the perilymph affect the endolymph in the membranous labyrinth, and thus excite the terminations of the acoustic nerve.

Membranous Labyrinth. — In the vestibule there are two membranous sacs, termed the utricle and the saccule. The *utricle* occupies the recessus ellipticus on the upper wall of the vestibule, and lies above and posterior to the saccule. Into it open the *membranous semicircular ducts* which lie in the bony semicircular canals.

Each semicircular duct corresponds in general form with the semicircular canal in which it lies, but it is of smaller diameter. Its convex margin is attached to the adjacent part of the wall of the bony canal.

The *saccule* is smaller, and occupies the recessus sphæricus on the anterior part of the medial wall of the vestibule. It communicates by means of a short narrow tube, termed the *canalis reuniens*, with the ductus cochlearis or membranous cochlear tube.

The saccule and the utricle are only indirectly brought into communication with one another; a slender tube termed the *ductus endolymphaticus*

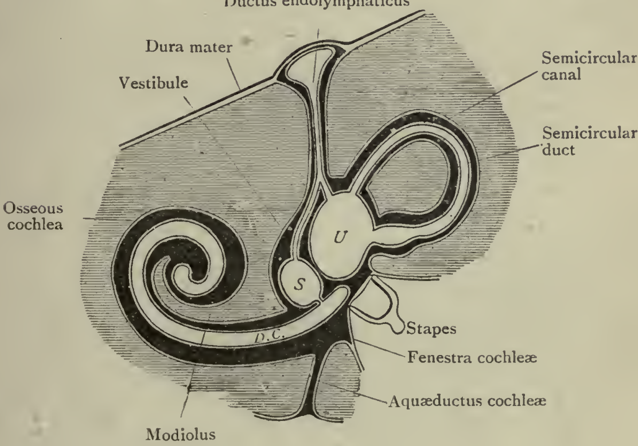


FIG. 225.—Diagram of the Osseous and Membranous Labyrinth. (Modified from Testut.)

U. Utricle. *S.* Saccule. *D.C.* Ductus cochlearis.

occupies the aquæductus vestibuli, and divides into two branches which pass respectively into the saccule and the utricle (Fig. 225).

The *ductus cochlearis*, or *scala media*, lies between the two scalæ of the bony cochlear tube. It ends blindly at each extremity, but close to its basal end it is brought into communication with the saccule by the *canalis reuniens*.

BULBUS OCULI.

THE bulbus oculi or eyeball is not perfectly spherical. Indeed, it may be said to be composed of the segments of two spheres. The anterior or corneal segment, which forms only about one-sixth of the entire eyeball, possesses a shorter radius than the posterior or scleral segment. The anterior, clear corneal part of the eyeball appears, therefore, as a convex window or prominence on the front of the globe of the eye. The terms *anterior pole* and *posterior pole* are respectively applied to the central points of the anterior and posterior segments of the eyeball. The imaginary line which joins the two poles receives the name of the *sagittal axis*, whilst another line drawn in a frontal direction around the globe of the eye, midway between the two poles, so as to divide the eyeball into two hemispheres, is termed the *equator*. Imaginary *meridional lines* also are drawn between the two poles so as to cut the equatorial line at right angles.

Dissection of the Eyeball.—A satisfactory dissection of the globe of the eye can be made only when the eyeball is fresh, or after it has been hardened for several days in a 10% solution of formol. In the dissecting-room it is often impossible to obtain suitable specimens; but it is always easy to procure eyeballs of the pig, sheep, or ox, and those suit the purpose admirably. It is advisable, however, that the dissector should complete his study of the organ by the examination of a fresh human eyeball obtained from the *post-mortem* room. In point of size, and also in other particulars, the eyeball of the pig more closely resembles the human eyeball than the eyeball of the sheep or ox; but it is perhaps better that the student should begin with the eyeball of the ox, because the necessary dissection can be more easily carried out in it than in smaller eyeballs.

When the dissector has provided himself with six eyeballs obtained from oxen, he should remove from them the conjunctiva, fascia bulbi, ocular muscles, and fat, which adhere to them. Pinching up, with the forceps, the conjunctiva and the fascia bulbi close to the corneal margin, he should snip through those layers with the scissors and divide them round the whole edge of the cornea. He can then easily strip all the soft parts from the surface of the sclera, working steadily backwards towards the entrance of the optic nerve. A little posterior to the equator of the eyeball the *venæ vorticosæ* will be noticed issuing from the sclera, at wide intervals from each other; and as the posterior aspect of the eyeball is approached the posterior ciliary arteries and the ciliary nerves will be seen piercing the sclera around the entrance of the optic nerve.

Before the student begins the actual dissection of the eyeball, it is important that he should obtain a general conception of the parts which compose it. That can be done by sections made through three hardened specimens in three different planes. One specimen should be divided, at the equator, into an anterior and a posterior portion. Another should be divided, in an antero-posterior direction, into a medial and a lateral half. A third should be divided horizontally and a portion of the vitreous body should be removed (Fig. 226). When the sections are made, they should be placed under water in a cork-lined tray, and preserved for reference as the study of the eyeball is proceeded with.

General Structure of the Eyeball.—The eyeball consists of three concentrically arranged coats enclosing a cavity in which three refracting media are placed.

The coats or tunics are: (1) an external fibrous envelope composed of a posterior, opaque part, called the *sclera*, and an anterior, clear transparent portion, called the *cornea*; (2) a middle vascular envelope, known as the *uveal tract*, in which three subdivisions are recognised, viz., a posterior part called the *chorioid*, an anterior portion termed the *iris*, which

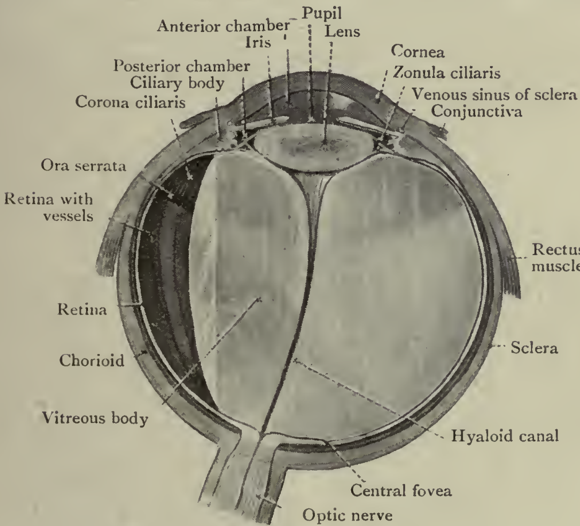


FIG. 226.—Diagrammatic section of Eyeball.

lies posterior to the cornea, and an intervening *ciliary body*; (3) the nervous internal tunic or *retina*, in which the fibres of the optic nerve are outspread.

The refracting media are: (1) the cornea; (2) posterior to the cornea a watery fluid called the *aqueous humour*, contained in a space partially subdivided by the iris into the *anterior* and *posterior chambers of the eye*; (3) the *crystalline lens*, behind the posterior chamber; and (4) the *vitreous body*, which occupies the posterior part of the interior of the eyeball.

Dissection.—The superficial surface of the sclera and of the cornea should now be examined; but to complete the study of the external tunic a further dissection is required. Select an eyeball for that purpose, and make an incision, with a sharp knife, through the sclera at the equator. The incision must be made carefully, and the moment that the subjacent black chorioid coat appears the knife should be laid aside. The cut edge of the sclera should now be seized with the forceps, and the incision carried completely round the eyeball, with the scissors, along the line of the equator. The outer fibrous tunic is thus divided into an anterior and a posterior portion. Both parts must now be raised from the subjacent structures. As the anterior portion is turned forwards, some resistance will be met with, close to the margin of the cornea; it is due to the attachment of the ciliary muscle to the deep surface of the sclera. The attachment can easily be broken through with the blunt point of the closed forceps; as soon as that is done the aqueous humour escapes. In the case of the posterior part of the sclera, the complete separation of the sclera can be effected by dividing the fibres of the optic nerve close to the point where they enter the sclera from the inner side.

When the above dissection is successfully carried out, the outer fibrous tunic is isolated in two portions, whilst a continuous view of the intermediate vascular coat is obtained. The eyeball, denuded of its external tunic, should now be placed in a shallow vessel filled with water.

Sclera.—The sclera is what is commonly known as the white of the eye. It is a dense, resistant tunic, opaque-white in colour, which envelops the posterior five-sixths of the globe of the eye. It is thickest posteriorly, and becomes thinner as it is traced forwards. Near the cornea, however, it again becomes thicker, owing to the accession of fibres which it receives from the tendons of the ocular muscles. Except at the entrance of the optic nerve and close to the margin of the cornea, where it adheres to the surface of the subjacent ciliary muscle, the deep surface of the sclera is very loosely attached to the chorioid coat. Some pigmented flocculent connective tissue, called the *lamina fusca*, connects the two coats and traverses what is, in reality, an extensive lymph space, termed the *perichorioidal space.*

The point at which the optic nerve pierces the sclera does not correspond with the posterior pole of the eyeball. The *optic entrance*, as it is termed, is situated about 3 mm. to the medial or nasal side of the posterior pole and 1 mm. below it. There the outer fibrous sheath of the optic nerve, which is derived from the dura mater, blends with the sclera, and the bundles of nerve fibres pass through a number of small apertures. The perforated portion of the sclera through which the fibres of the optic nerve pass is called the *lamina cribrosa.*

The sclera is pierced also by numerous blood-vessels and nerves. The long and short posterior ciliary arteries, with the ciliary nerves, perforate the sclera around the optic entrance; four or five venæ vorticosæ issue from the interior of the eyeball by piercing the sclera a short distance posterior to the equator, at wide intervals from each other; whilst the anterior ciliary arteries pierce it near the corneal margin.

Anteriorly, the sclera is not only contiguous to, but is directly and structurally continuous with, the cornea. The region of union is termed the *corneo-scleral junction*, and the faint groove on the surface, which corresponds with it, receives the name of the *scleral sulcus*. At the junction the

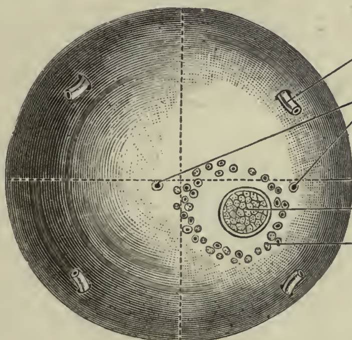


FIG. 227.—Diagram of the posterior aspect of the Left Eyeball. The excentric position of the optic entrance is somewhat exaggerated. (After Testut, modified.)

scleral tissue slightly overlaps the corneal tissue; therefore the line of union, when seen in section, is oblique. Close to the corneo-scleral junction, a minute canal in the substance of the sclera, termed the *sinus venosus scleræ* (O.T. canal of Schlemm), encircles the margin of the cornea.

Cornea.—The cornea forms the anterior sixth of the outer tunic of the eye. It is transparent and glass-like, and it forms the window through which the rays of light gain admittance into the eyeball. The curvature of the cornea is more accentuated than that of the sclera, and thus it constitutes the segment of a smaller sphere. When viewed from the posterior aspect it appears circular, but when looked at from the front it is seen to be slightly wider in the transverse direction than in the vertical. That is due to the fact that the sclera overlaps it to a greater extent above and below than it does at the sides. The posterior, concave surface of the cornea forms the anterior boundary of the anterior chamber of the eyeball, and is separated by the aqueous humour from the anterior surface of the iris.

The anterior convex surface of the cornea is clothed with the conjunctiva, reduced to a transparent epithelial layer. On its posterior aspect there is an elastic, glassy stratum, termed the *posterior elastic lamina*. When the cornea is relaxed that membrane becomes wrinkled, and it can be torn away in shreds from the proper corneal tissue.

Ligamentum Pectinatum Iridis.—At the margin of the cornea the posterior elastic lamina is fibrillar, and some of its fibres are continued into the iris, forming the *ligamentum pectinatum iridis*, whilst others are prolonged backwards into the chorioid and the sclera. The ligamentum pectinatum iridis bridges across the angle between the cornea and the iris, and the bundles of fibres into which the posterior elastic lamina breaks up in that region constitute the boundaries of an annular mesh-work or sponge-like series of minute spaces termed the *spatia anguli iridis* (O.T. *spaces of Fontana*). The spaces communicate with the anterior chamber of the eyeball, and are filled with aqueous humour.

Tunica Vasculosa Oculi.—The middle or vascular tunic, frequently spoken of as the uveal tract, is exposed, in its entire extent, in the eyeball from which the sclera and the cornea have been removed. It is separable into three parts—(1) a posterior portion, the chorioidea; (2) a middle part, the corpus ciliare; and (3) an anterior segment, the iris.

Chorioidea.—The chorioid is the largest part of the vascular tunic. It lines the posterior segment of the eyeball, between the sclera externally and the retina internally. It is thickest posteriorly, where it is pierced by the optic nerve, and becomes thinner anteriorly, as it approaches its union with the ciliary body. Its superficial surface is connected with the deep surface of the sclera by some lax connective tissue, called the *lamina fusca*, and also by blood-vessels and nerves which pass from the one into the other. The deep surface of the chorioid is moulded upon the retina and is covered with a layer of deeply-pigmented cells which usually adheres to the chorioid when that tunic is removed, although, in reality, it is a portion of the retina.

In the eyes of many mammals, but not in man, the posterior part of the chorioid, when viewed from the front, presents an extensive brightly-coloured area, which exhibits a metallic lustre. The appearance is due to the presence of an additional layer in the chorioid, termed the *tapetum*. In the horse, elephant, and ox, the tapetum is composed of fibres (tapetum fibrosum); in carnivora, it is formed of cells (tapetum cellulosum). In the ox, it is a brilliant green colour with a golden lustre; in the dog, it is white with a bluish border; in the horse, it is blue with a silvery lustre.

The chief bulk of the chorioid coat is composed of blood vessels. They are arranged in two well-marked layers, viz.,

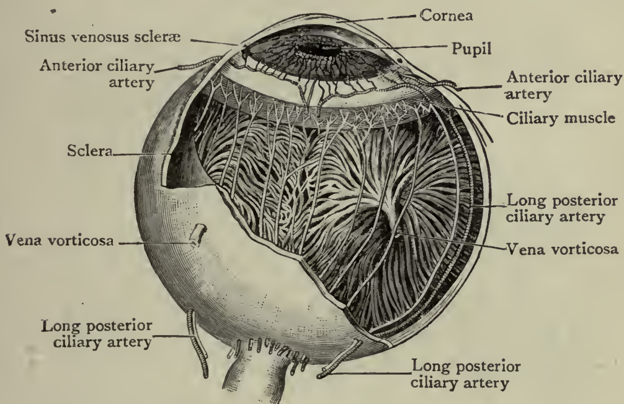


FIG. 228.—Dissection of the Eyeball showing the Vascular Tunic and the Arrangement of the Ciliary Nerves and Vessels.

a deep, closely-meshed capillary layer called the *lamina choriocapillaris*, and a more superficial venous layer composed of the *vasa vorticosa*. The short posterior ciliary arteries pass forwards between the two vascular layers.

The eyeball in which the outer surface of the chorioid is exposed should be immersed in water and the pigment washed out of it by means of a camel-hair brush. The vasa vorticosa will then appear as white curved lines converging towards four or five points, from which the venæ vorticosæ take origin (Fig. 228).

Corpus Ciliare.—The ciliary body is separable into an antero-external part, the orbiculus ciliaris, and a postero-internal part, the corona ciliaris.

The *orbiculus ciliaris* consists of the ciliary muscle, the ganglionated ciliary nerve plexus, and plexuses of arteries and veins associated with the iris and ciliary body. It is continuous with the iris internally, the sclera anteriorly, and the corona ciliaris and the chorioid posteriorly.

Musculus Ciliaris.—The ciliary muscle is composed of involuntary muscular tissue. The arrangement of its fibres can be seen only when thin sections of the eyeball are examined under the microscope. It is then obvious that the fibres are disposed in two groups, viz., a radiating and a circular.

The *radiating fibres* arise from the deep aspect of the sclera close to the margin of the cornea. From their origin they radiate backwards, in a meridional direction, and gain

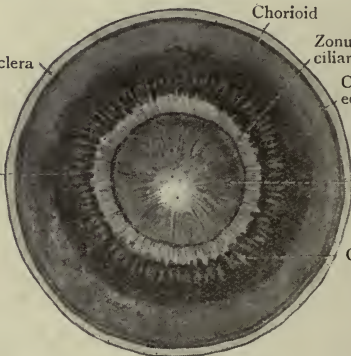


FIG. 229.—Posterior view of Lens and Zonula Ciliaris. (Professor Arthur Thomson.)

insertion into the chorioid coat in the region of the ciliary processes. The *circular fibres* consist of two or three bundles placed upon the deep aspect of the radiating portion of the muscle. They form a muscular ring around the outer circumference of the iris. The ciliary muscle is supplied by the oculo-motor nerve. It draws the anterior part of the chorioid forwards, and so relaxes the suspensory ligament of the lens, which then becomes more convex on account of its own elasticity.

Dissection.—To obtain a view of the ciliary processes, a frontal section should be made through an eyeball, a short distance anterior to the equator. The portion of the vitreous body which occupies the posterior segment of the eyeball should be carefully removed. When that is done, the deep aspect of the corona ciliaris will be seen. It is covered with ciliary processes which radiate backwards from the circumference of the crystalline lens. Wash out the pigment from the anterior part of the vascular tunic, in order to display the arrangement of the processes more fully.

A second dissection may be made, in another eyeball, with the object of exposing the ciliary processes from the front. In that case remove the cornea by cutting round the corneo-scleral junction with the scissors. The iris is then brought conspicuously into view, and may, with advantage, be studied at this stage. Several cuts in the meridional direction, and at equal intervals from each other, should, in the next place, be made

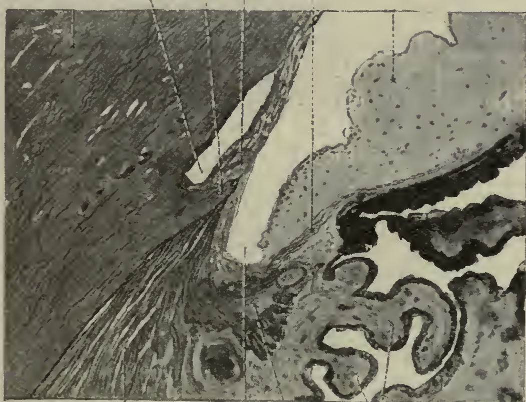


FIG. 302.—Section of Iridial Angle. (Prof. Arthur Thomson.)

through the anterior part of the sclera. The specimen should then be placed in a cork-lined tray, filled with water, and the strips of sclera should be separated from the ciliary muscle, bent aside and pinned to the cork. The last step in the dissection consists in the removal of the iris.

The *corona ciliaris* lies on the posterior aspect of the orbiculus ciliaris and is continuous, anteriorly, with the iris, and, posteriorly, with the chorioid. It consists of a number of larger folds, called the *processus ciliares*, 70 to 72 in number, which are intermingled with a number of smaller folds, called the *plicæ ciliares*. The ciliary processes extend from the anterior margin of the chorioid to the anterior margin of the corona ciliaris, where they end in bulbous extremities. The bulbous ends occupy the space between the peripheral margin of the iris and the margin of the anterior surface of the crystalline lens, and they form the peripheral boundary of the posterior chamber of the eyeball. The *plicæ ciliares* are much less prominent than the ciliary processes. Both the processes and the folds are in relation, posteriorly, with the hyaloid membrane, which separates them from the vitreous body, and with the peripheral part of the zonula ciliaris (see p. 544) to which they are attached.

Iris.—The iris lies anterior to the crystalline lens, and it is separated from the cornea by the anterior chamber filled with aqueous humour. By its circumference it is continuous with the ciliary body, and it is connected, by the ligamentum pectinatum iridis, with the margin of the cornea.

The iris is circular in form, it is coloured differently in different subjects, and it has a central perforation termed the *pupil.* Its anterior surface is faintly striated in a radial direction. Its posterior surface is deeply pigmented. The pupil presents a very nearly circular outline,[1] and during life it constantly varies in its dimensions so as to control the amount of light which is admitted into the interior of the eyeball. The changes in the size of the pupil are produced by the two groups of involuntary muscular fibres which are present in the substance of the iris. One group is composed of muscular fibres arranged circularly around the pupil in the form of a *sphincter*; the second group consists of fibres which have a radial direction, and pass from the sphincter towards the circumference of the iris, so as to constitute a *dilatator muscle.* By some anatomists these radial fibres are considered to be *elastic* and not *muscular.* The circular fibres, which act as a sphincter, are supplied by the oculo-motor nerve. The dilator fibres are supplied by sympathetic nerve fibres.

Ciliary Nerves.—The ciliary nerves arise from the ciliary ganglion and the naso-ciliary nerve. They pierce the sclera around the optic entrance, and extend forwards, between the sclera and the chorioid, in the perichorioidal lymph space. They will be seen, in the specimen in which the sclera has

[1] It may be as well to mention here that the pupil in the ox and the sheep is greatly elongated in the transverse direction. In the pig, however, it is approximately circular.

been turned aside in separate flaps, in the form of delicate white filaments (Fig. 228). In the posterior part of the eyeball they occupy grooves on the deep surface of the sclera, and can be separated from it only with difficulty. Reaching the ciliary zone the ciliary nerves break into branches, which join in a plexiform manner and send twigs to the ciliary muscle, the iris, and the cornea. The long ciliary nerves are sensory nerves. The short ciliary nerves contain motor fibres derived from the motor-oculi, sensory fibres from the naso-ciliary nerve, and sympathetic fibres which convey motor impulses to the dilator muscle of the iris.

Ciliary Arteries.—There are three groups of ciliary arteries: (1) the short posterior ciliary arteries; (2) the long posterior ciliary arteries; and (3) the anterior ciliary arteries.

The *short posterior ciliary arteries*, branches of the ophthalmic, pierce the sclera around the optic entrance, and are distributed in the chorioid coat between the venæ vorticosæ and the lamina chorio-capillaris.

The *long posterior ciliary arteries*, also branches of the ophthalmic, are only two in number. They perforate the sclera, one on the medial side of the optic nerve and the other on its lateral side (Fig. 227), a short distance beyond the short ciliary arteries, and then pass forwards between the sclera and the chorioid. When they gain the ciliary zone each artery divides into an ascending and a descending branch, which anastomose with the anterior ciliary arteries at the periphery of the iris, and form an arterial ring termed the *circulus iridis major*. Branches are given off from the major circle to the ciliary muscle, the ciliary processes, and the iris.

The *circulus iridis minor* is the name applied to a second arterial ring in the iris at the outer border of the sphincter pupillæ.

The *anterior ciliary arteries* are very small twigs which arise from the branches of supply to the recti muscles. They pierce the sclera close to the margin of the cornea, take part in the formation of the circulus iridis major, and send twigs to the ciliary processes.

Venæ Vorticosæ.—From each venous vortex in the chorioid a large vein arises, which makes its exit from the eyeball by piercing the sclera, obliquely, a short distance posterior to the equator. They are four or five in number.

Dissection.—The vitreous body and retina, in the posterior part of the eyeball which was cut into two for the purpose of exposing the ciliary processes from the posterior aspect, should now be dislodged. By raising the chorioid coat from the deep surface of the sclera, under a flow of water from the tap, the dissector will bring into view the venæ vorticosæ as they enter the deep surface of the sclera. When the venæ vorticosæ are divided, and the separation of the two coats is carried backwards towards the optic entrance, the short posterior ciliary arteries, as they emerge from the sclera and enter the posterior part of the chorioid, will be seen.

To expose the external surface of the retina take the eyeball from which the sclera and cornea have been removed, and carefully strip off the iris, ciliary processes, and the chorioid, piecemeal, under water.

Retina.—The retina is composed of two strata—viz., a thin *pigmentary layer*, which adheres to the deep surface of the chorioid coat, and has been removed with it, and a delicate *nervous layer*, which is moulded on the surface of the vitreous body, but presents no attachment to it except at the optic entrance. The retina extends forwards, beyond the equator of the eyeball, and, a short distance from the ciliary zone, it appears to end in a well-defined, wavy or festooned border termed the *ora serrata*. This appearance, however, is somewhat deceptive. The nerve elements, it is true, come to an end along the ora serrata, but a lamina in continuity with the retina is in reality prolonged forwards as far as the margin of the pupil. The part in relation to the ciliary processes is exceedingly thin, and cannot be detected by the naked eye. It is termed the *pars ciliaris retinæ*. The portion on the deep surface of the iris is called the *stratum pigmenti iridis*.

During life the *retina proper* is transparent, but after death it soon assumes a dull greyish tint and becomes opaque. Posteriorly it is tied down at the optic entrance. When viewed from the anterior aspect the optic entrance appears as a conspicuous circular disc termed the *papilla nervi optici*, upon which is a depression, the *excavatio papillæ*. From that spot the optic nerve fibres radiate out so as to form the deep or anterior layer of the retina. The optic disc, in correspondence with the entrance of the optic nerve, lies to the medial or nasal side of the antero-posterior axis of the eyeball. Exactly in the centre of the human retina, and therefore in the axis of the globe of the eye, there is a small yellowish spot termed the *macula lutea*.[1] It is somewhat oval in

[1] There is no macula lutea in the eyeball of the ox or sheep.

outline, and a depression in its centre is called the *fovea centralis.*

Retinal Arteries and Veins.—In a fresh eyeball the *arteria centralis retinæ* will be seen entering the retina at the optic disc.[1] It immediately divides into a superior and an inferior division, and each of them breaks up into a large lateral or temporal division, and a smaller medial or nasal division. The various branches of the terminal divisions ramify in the retina as far as the ora serrata; but they do not anastomose with each other, nor with any of the other arteries in the eyeball.

The *retinal veins* converge upon the optic disc, and disappear into the substance of the optic nerve in the form of two small trunks which soon unite.

The retinal vessels, the optic disc, and the macula can all be examined in the living eye by means of the ophthalmoscope. The red reflex obtained from the fundus of the eyeball, so examined, is produced by the blood in the lamina chorio-capillaris.

Dissection.—**For the study of the vitreous body and the crystalline lens, which together may be termed the "eye-kernel," it is better to take an eyeball which is not perfectly fresh (Anderson Stuart). The eyeball selected for this purpose should be allowed to stand untouched from one to three days, according to the season. Divide the coats of the eye round the equator; gently separate the cut edges, and turn the coats forwards and backwards, and the "eye-kernel" will slip out. It should be allowed to drop into a vessel filled with clean water. The examination of the parts forming the "eye-kernel" will be greatly facilitated if it is placed *en masse* in strong picro-carmine solution for a few minutes. When removed from the staining fluid, it should be well washed in water. In this way the hyaloid membrane enclosing the vitreous body, the capsule of the lens, and the zonula ciliaris, are stained red, and their connections become very apparent (Anderson Stuart).**

Corpus Vitreum.—The vitreous body is a soft, yielding, transparent, jelly-like body, which occupies the posterior four-fifths of the interior of the eyeball. The retina is spread over its surface as far forwards as the ora serrata, but is in no way attached to it, except at the optic disc. Anterior to the ora serrata, the ciliary processes are applied to the vitreous body and indent its surface. More anteriorly, the vitreous body presents a deep concavity, called the *fossa*

[1] When the living retina is examined with the aid of the ophthalmoscope it is not the vessels which are seen but the blood circulating through them, for the walls of the vessels are transparent.

hyaloidea, for the reception of the posterior, convex surface of the crystalline lens.

The substance of the vitreous body is enclosed within a delicate transparent membrane, which completely envelops it, and receives the name of the *hyaloid membrane.* Extending forwards through the midst of the vitreous mass, from the region of the optic disc to the crystalline lens, is a minute canal, lined with a tube-like prolongation of the hyaloid membrane, and containing a watery fluid. The canal is termed the *hyaloid canal*; it represents the path taken by a branch of the arteria centralis retinæ, which, in the fœtus, extends to and supplies the capsule of the lens, but afterwards disappears.

The hyaloid canal, as a rule, cannot be seen in an ordinary dissection of the eyeball; but if the "eye-kernel" is shaken up in the picro-carmine solution as recommended by Anderson Stuart, it may sometimes be rendered evident through the staining fluid entering it. It is represented diagrammatically in Fig. 226.

Zonula Ciliaris (O.T. **Zonula of Zinn**).—Between the corona ciliaris externally and the margin of the lens internally lies a fibrous membrane called the zonula ciliaris. Its peripheral margin is attached to the posterior surfaces of the ciliary processes and the hyaloid membrane, and its central margin is connected with the lens. As it approaches the margin of the crystalline lens, it splits into two parts, viz., an exceedingly delicate, deep lamina, which lines the fossa hyaloidea, and a more superficial, stronger part, which becomes attached to the capsule of the crystalline lens.

The zonula ciliaris lies subjacent to the ciliary processes, and is radially wrinkled in correspondence with the depressions between the processes. Thus, the elevations or wrinkles of the zonula extend into the intervals between the ciliary processes, whilst the ciliary processes in their turn lie in the depressions between the wrinkles of the zonula. When the eye is fresh, these opposing parts are closely adherent.

The zonula ciliaris is strengthened by radially directed elastic fibres, and the anterior and stronger of the two layers into which it divides is called the *suspensory ligament of the lens*. It is attached, mainly, to the anterior surface of the capsule of the lens a short distance beyond the margin of that body, but this is not the only attachment of the suspensory ligament. Some of its fibres are attached to the circumference or equator of the lens (equatorial fibres), whilst others are fixed to its posterior surface close to its margin (post-equatorial fibres).

In that way the crystalline lens is firmly held in its place in the fossa hyaloidea. Further, the degree of tension of its suspensory ligament is influenced by the radiating fibres of the ciliary muscle, which by their contraction pull upon the ciliary processes, and produce relaxation of the zonula ciliaris.

Spatia Zonularia (O.T. **Canal of Petit**).—In reality the spatia zonularia constitute a more or less continuous circular lymph space, which surrounds the circumference of the lens.

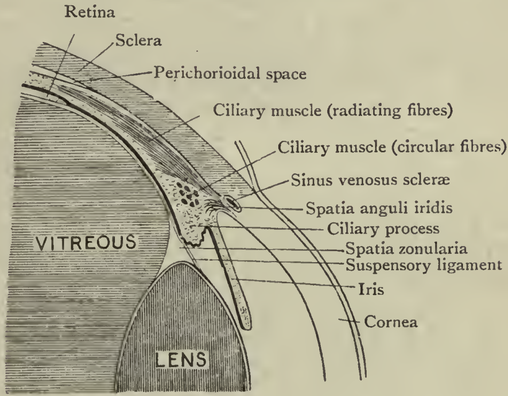


FIG. 231.—Diagrammatic representation of the Ciliary Region, as seen in vertical section.

It lies between the anterior and posterior layers of the suspensory ligament and is filled with a watery fluid.

If the point of a fine blow-pipe is introduced into the spatia zonularis through the suspensory ligament, the spatia can be partially, or, perhaps, completely, inflated with air. Then the spatia present, collectively, the appearance of a circular sacculated canal.

Dissection.—Remove the crystalline lens by snipping through the suspensory ligament with scissors.

Lens Crystallina.—The crystalline lens is a biconvex, solid, and transparent structure which lies between the iris and the vitreous body, in the posterior wall of the posterior and anterior chambers. It is enclosed within a glassy, elastic capsule, to which the different parts of the zonula ciliaris are firmly cemented, and it presents for study an anterior surface, a posterior surface, and a circumference or equator.

The *anterior surface* is not so highly curved as the posterior surface. Its central part, which corresponds with the pupillary aperture of the iris, looks, through the pupil, into the anterior chamber of the eye. Around that part the margin of the pupillary orifice of the iris is in contact with the lens, whilst nearer the equator the anterior surface of the lens is separated from the iris by the fluid in the posterior chamber of the eyeball. The *posterior surface* of the lens presents a higher degree of curvature than the anterior surface, and is received into the fossa hyaloidea of the vitreous body. The *equator* or *circumference* is rounded. It forms one of the boundaries of the spatia zonularia. The manner in which the zonula ciliaris is attached to the capsule in this vicinity has been described already.

Faint radiating lines may be seen on both surfaces of the lens, and they give a clue to its structure. They indicate the planes along which the extremities of the lens-fibres come into apposition with each other.

The *capsule* of the lens is a resistant glassy membrane, which is considerably thicker anteriorly than posteriorly.

> ***Dissection.***—The anterior wall of the capsule may now be divided with a sharp knife. A little pressure will cause the body of the lens to escape through the opening. The stained capsule can be very advantageously studied whilst floating in water.
>
> If the lens body is compressed between the finger and thumb, it will be noted that the outer portion or *cortical part* is soft, whilst the central part or *nucleus* is distinctly firmer. When the lens is hardened in alcohol it can easily be proved that it is composed of numerous concentrically arranged laminæ.

Chambers of the Eyeball.—The *anterior chamber* of the eyeball is the space between the cornea, anteriorly, and the iris and central part of the lens, posteriorly. At the iridocorneal angle it is bounded by the ligamentum pectinatum iridis, and there the aqueous humour which fills this chamber finds access to the spatia anguli iridis.

The *posterior chamber* is a circular space or interval which is bounded, anteriorly, by the posterior surface of the iris, and, posteriorly, by the circumferential part of the anterior face of the lens. Peripherally, the posterior chamber is closed by the thick anterior projecting ends of the ciliary processes. It also is filled with aqueous humour.

INDEX.

Printed in Great Britain by R. & R. CLARK, LIMITED, *Edinburgh.*