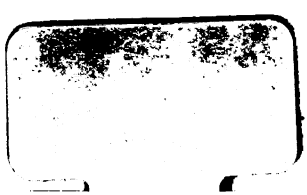
HAND-BOOK OF ANATOMY

YOUNG



HANDBOOK

OF

ANATOMY

BEING A COMPLETE COMPEND OF ANATOMY, INCLUDING THE ANATOMY OF THE VISCERA AND NUMEROUS TABLES

BY

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SECOND EDITION, REVISED AND ENLARGED

WITH 171 ENGRAVINGS, SOME IN COLORS

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PREFACE TO REVISED EDITION.

THE demand for a new edition has afforded an opportunity to thoroughly revise the text and illustrations, and to add such changes of description and nomenclature as have been introduced into modern methods of teaching.

Whenever it seemed necessary or advisable sections have been entirely rewritten, but the same attention to conciseness and accuracy has been observed as in the former edition.

The size of the pages has been considerably enlarged and increased in number, and the illustrations increased from 76 to 171. Many improved cuts replace those used in the former edition and full-page engraved plates have been inserted in the text where they will be most serviceable.

In its preparation, the last editions of both Morris and Gray have been freely consulted, so that it can be used with either of these standard works.

As in the former edition, although prepared particularly for students, sufficient descriptive matter has been added to render it valuable to the busy practitioner, particularly in the sections upon the Viscera, Special Senses, Vascular System, the Nervous System, and Surgical Anatomy.

Special attention has been given to the anatomy of the brain and nervous system, which will be found to compare favorably with the descriptions in larger works.

The author has been much gratified to observe the tenacity with which students and physicians have retained the work for reference.

The author would acknowledge his obligation to Dr. Richard F. Gerlach, who has distinguished himself by his careful and accurate work upon Deaver's "Surgical Anatomy," for valuable assistance upon the revision.

J. K. Y.

PREFACE.

THE object of this little book is, as its title indicates, to furnish a concise though *complete synopsis* of human anatomy for the use of students of medicine and others.

Appreciating, from a personal contact with students, the limited time at their disposal and the unlimited amount of medical material to be digested, the author has endeavored, by well-selected wood-cuts, typographical arrangement, and numerous tables, to facilitate the acquisition of a subject as difficult as it is essential, and elegance of diction has therefore been sacrificed to conciseness and accuracy.

In its preparation the last edition of Gray's "Anatomy" [edited by Keen], as the work most largely employed, has been selected as the *standard,* but Leidy, Quain, Allen, Holden, Henle, Schaffer, Klein, Brown Aids, and others, have been freely used, and on the special subjects Lusk, Spiegelberg, Savage, Schroeder, Budin, Treve's "Surgical Applied Anatomy," and the "American System of Dentistry" have been consulted. Although prepared particularly for students, sufficient descriptive matter has been added to render it valuable to the busy practitioner, particularly the sections on the Viscera, Special Senses, Vascular System, and Surgical Anatomy. The aim throughout has been to make it as thoroughly complete and accurate as possible, and at the same time readily accessible for reference or study.

The writer would acknowledge his obligations to Messrs. S. Z. Durborow and C. W. Holly, medical students at the University, for assistance in the correction of proof.

J. K. Y.

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INTRODUCTORY.

THE term "anatomy," derived from the Greek ἀνά, "through," and τέμνω, "to cut," signifies dissection, but has been appropriated to the science which treats of the apparent properties of organized bodies. It is the science of organization. Anatomy is divided into *vegetable*, which treats of the structures and properties of vegetal bodies; *comparative*, which treats of the anatomy of animals; *human*, which treats of the anatomy of man in a physiological or healthy state; *pathological*, which treats of the anatomy of the diseased human body, etc.

Human anatomy is subdivided into general, descriptive, and surgical.

General anatomy treats of the minute structure or physical elements of the organs of the body. It is also called microscopical anatomy, or histology. It comprises seven distinct classes:—

Corpuscular, including the blood, spleen, etc.
Epithelial, including mucous membranes, epidermis, glands, etc.
Cartilaginous, including cartilage, fibro-cartilage, etc.
Osseous, including all bony structures.
Muscular, including flesh and muscle generally.
Nervous, including the proper nerve elements.
Connective, including white fibrous, elastic, adipose, and neuroglia.

Descriptive or *special anatomy* treats of the various properties of the organs arranged into systems; hence the name systematic. It includes:—

Osteology, the anatomy of the bones.
Syndesmology, the anatomy of the joints.
Myology, the anatomy of the muscles.
Angiology, the anatomy of the vessels.
Neurology, the anatomy of the nerves.
Splanchnology, the anatomy of the viscera.
Dermatology, the anatomy of the skin.
Genesiology, the anatomy of the generative organs.
Adenology, the anatomy of the glands, etc., etc.

Surgical or *topographical anatomy* treats of the relative position of organs to one another and to the surrounding parts in special regions of the body, as the axilla, neck, or groin.

OSTEOLOGY.

THE frame-work of the body is composed of bones, which constitute the skeleton. This in the adult consists of 206 bones, including the ossicula auditus: Excluding the ear ossicles, the number is 200, or excluding also the two patellæ and the hyoid bone the number is 197. Spine (including coccyx and sacrum) 26, cranium 8, face 14, ribs, sternum, and os hyoides 26, upper extremity 64, lower extremity 62, ear ossicles, 6.

The bones of the *head* number 22, consisting of

Eight *cranial bones*, the frontal, 2 parietal, occipital, 2 temporal, the sphenoid and ethmoid bones; 14 facial bones, 2 lachrymal, 2 nasal, 2 malar, 2 superior maxillæ, 2 palate, 2 turbinal, 1 vomer, and 1 inferior maxilla.

The bones of the *trunk* number 52, comprising

Twenty-six vertebræ, 7 cervical, 12 dorsal, 5 lumbar, 1 sacrum and 1 coccyx.

Twenty-six of the thorax, 7 pairs of true ribs, 3 pairs of false ribs, 2 pairs of floating ribs, the sternum and os hyoides.

The bones of the skull, face, thorax, and vertebral column are known as the axial skeleton, and consists of 74 segments.

The bones of the upper extremity number 64, comprising on either side

Two shoulder, clavicle and scapula; 1 arm, humerus; 2 forearm, radius and ulna; 8 wrist (carpus), scaphoid, semi-lunar, cuneiform, pisiform, trapezium, trapezoid, os magnum, and unciform; 19 hand, 5 metacarpal and 14 phalanges.

The bones of the lower extremity number 62, comprising on either side

One hip, divided into 3 portions, the ilium, ischium, and pubes; 1 thigh, the femur; 2 leg, tibia and fibula; 1 knee, the patella; 26 foot, 7 tarsal bones, the astragalus, os calcis, scaphoid, cuboid, external, middle, and internal cuneiform; 5 metatarsal bones, and 14 phalanges.

The bones of the shoulder girdle, upper extermities, pelvic girdle, and lower extremities are known as the appendicular skeleton, and consists of 126 segments. They are divided into long, short, flat or tabular, and irregular.

Long bones, such as femur, humerus, or radius, consist of shaft or diaphysis, and two extremities or epiphyses.

The shaft or *diaphysis* is a cylindrical tube composed externally of compact tissue and internally of cancellous tissue, the centre being hollowed out by the *medullary canal.*

The *epiphyses,* or extremities, are expanded for articulation, and are composed of a mass of solid cancellous tissue with a thin coating of compact tissue.

The *short bones,* as tarsus or carpus, are small, compact, irregular cubes.

Flat bones, as those of skull and shoulder-blade, afford extensive surfaces for protection or muscular attachment.

Under *irregular* or mixed bones are classed the vertebral, sphenoid, maxillary bones, and such that could not be placed under either of the other heads.

The *surfaces* of the bones are marked by certain eminences and depressions, which have received the following names:—

An apophysis is a prominent excrescence formed directly upon a bone, and is distinguished from

An epiphysis, which has been formed from a distinct centre and separated by cartilage, but afterward united to the bone.

A head is a rounded, smooth, articular eminence for articulation.

A condyle is an irregular prominence for muscular attachment.

A trochanter is a large prominence for the attachment of rotator muscles.

A tuberosity is a broad, uneven eminence.

A tubercle is a small tuberosity.

A spine is a sharp-pointed eminence.

A line, or ridge, is a rough, narrow elevation, extending some distance.

Others, from their fancied resemblance to ordinary objects, have received the following names:—

Coronoid, like a crown; coracoid, like a crow's beak; unciform, or hamular, hook-like; malleolar, like a mallet; mastoid, nipple-like; zygoma, yoke-like; pterygoid, wing-like; odontoid, tooth-like; spinous, thorn-like; styloid, pen-like; rostrum, a beak; vaginal, ensheathing; squamous, scaly; conoid, cone-like.

The *cavities* of bones are divided into the articular and the non-articular.

The articular are named acetabulum, measure-like; glenoid, hollow; cotyloid, cup-like; facet, smooth; trochlear, pulley-like; alveolar, socket-like.

The non-articular cavities are named notches, fissures, grooves, furrows, fossæ, hiatus, foramina, canals, sinuses, aqueducts, cells, depressions, meatuses, etc.

Composition of Bone.—Adult human bones have a specific gravity of 1.92, and are composed of about one-third (33.30) organic or animal matter, principally gelatin, and two-thirds inorganic or mineral matter, as follows:—

Gelatin and blood-vessels, 33.30; phosphate, carbonate, and fluoride of calcium, 64.34; soda, sodium chloride, and magnesium phosphate, 2.36: total, 100.

Structure of Bone.—In *structure* they consist of an ivory-like *compact substance,* inclosing a lamellar, reticular *cancellous substance.*

They are covered with periosteum, and their cavities are lined with endosteum and filled with medulla, or marrow.

Periosteum is a fibro-vascular membrane, composed of two layers, the outer formed chiefly of connective tissue, the inner composed of several layers of elastic fibres, the deepest of which is the "osteogenic," or bone-producing layer. The tendons and ligaments are attached to the periosteum by a mutual interlacement of the fibres.

Endosteum, medullary membrane or internal periosteum, is a delicate, highly vascular membrane lining the cylindrical cavity of long bones.

Medulla, or bone-marrow, is of two kinds, the red in the flat and irregular bones, and the yellow in the shafts of adult long bones. The red marrow has few blood-vessels, but many corpuscular elements. These may be divided into three groups: 1, red nucleated true "marrow-cells;" 2, large pinkish cells, "myelo-plaques" of Robin, supposed to be the source of the red blood-corpuscles; and 3, *giant cells,* or "osteoclasts."

The yellow marrow contains numerous blood-vessels, a few "marrow-cells," and a large quantity of fat which imparts to it its color.

Blood-vessels of Bone.—The *arteries* consist of three sets: The arteries of the (1) compact and (2) cancellous tissue are derived chiefly from the periosteum, the latter being larger and less numerous. The medullary canal of long bones has (3) one or more nutrient arteries, which penetrate the compact tissue obliquely and divide into two branches, one passing upward, the other downward, in the canal. All the arteries anastomose freely with each other.

The *veins* consist of three sets also: 1. The veins of the compact substance are small and join the periosteum. 2. The veins of the cancellous tissue do not accompany the arteries, but in certain localities form large, tortuous channels, as in the diploic veins of the cranium. In the long bones they emerge at the ends near the articular surfaces. 3. The nutrient arteries are accompanied by one or more large veins, which emerge at the nutrient foramen.

Lymphatics and *nerves* are numerous in the periosteum and are also found in the substance of the bone.

Microscopical Appearance.—Microscopically, bone-tissue consists of concentric layers, or *lamellæ,* arranged about the course of a vascular or Haversian canal $^{1}/_{16000}$ inch in diameter. In and between these plates of bone-tissue are minute cavities, or *lacunæ,* each containing a bone-cell, or "osteoblast," and from which diverge in every direction minute canals, or *canaliculi,*

connecting the lacunæ with each other and with the Haversian canals. Each canaliculus contains an artery, vein, and lymphatic (Schaffer). In this manner every part of the osseous substance communicates.

Development.—The development of bone is effected in two ways—(1) from cartilage, the intra-cartilaginous; and (2) from membrane, the intra-membranous; the former occurring at the base of the skull for the protection of vital centres, or in the extremities to secure rigidity of the parts.

In the *intra-cartilaginous* the parts are first formed in cartilage and then converted into bone. The process is as follows: The cartilage cells at the "centre of ossification" become enlarged and arranged in rows. The cartilaginous matrix also increases and separates the cells. Lime salts are deposited between the rows of cells, inclosing them in oblong spaces called *primary areolæ.*

Blood-vessels from the deep or osteogenic layer of the periosteum, carrying numerous osteoblasts (bone-forming cells), and osteoclasts (bone-absorbing cells), pass into the area of calcified cartilage (centre of ossification). The osteoblasts replace the calcified cartilage, which is absorbed, with new bone, which latter is absorbed in part (tunneled) by the osteoclasts to form the medullary spaces or marrow cavity.

The walls of the spaces are gradually thickened by successive layers of osteoblasts, forming lamellæ of bone, till nothing remains but a channel—the Haversian canal.

The perichondrium having been in the meantime converted into periosteum, the osteogenic, or vascular, layer of this membrane furnishes a layer of osteoblasts that form enveloping, circumferential layers of bone.

Thus, from the osteoblasts all the structures of bone are produced; the remains of a group of cells constitute an Haversian canal, the layers deposited by them and the adjacent cells, the lamellæ, and the isolated, persistent cells (osteoblasts) form the contents of the lacunæ, or "true bone-cells," with their nutrient canaliculi diverging from them.

In the *intra-membranous* form the parts are first formed in membrane, and from one or more centres of ossification lime salts are deposited in radiating spiculæ, or *osteogenic fibres,* inclosing the *osteoblasts.*

From these fibres the process spreads, and vessels from the neighboring parts pass into it and form Haversian canals.

The formation of the lamellæ and the lacunæ is essentially the same as in the intra-cartilaginous, and in most bones both processes go on simultaneously.

Ossification appears first in the clavicle and inferior maxilla (from fifth to seventh week) and last in the pisiform bone (twelfth year). The epiphyses ossify from birth and unite from the age of puberty on to maturity, in reverse order to the appearance of ossification, being regulated, apparently, by the direction of the nutrient artery in the upper extremity toward the elbow and in the lower extremity from the knee. The only exception to this rule is the lower end of the fibula, which ossifies and also becomes united before the upper (*vide* Table of Ossification). In bones with only one epiphysis the artery is directed toward the other extremity.

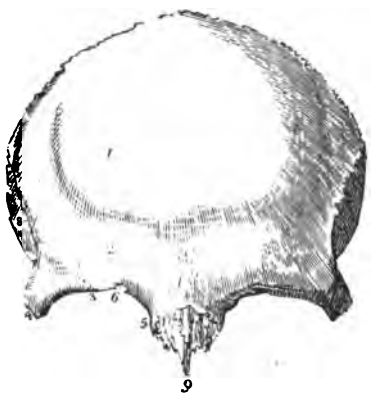

FIG. 1.

1, frontal eminence; 2, superciliary ridge; 3, supra-orbital arch; 4, external angular process; 5, internal angular process; 6, supra-orbital notch; 7, nasal eminence; 8, temporal ridge; 9, nasal spine.

Growth of Bones.—Long bones grow in thickness from the periosteum and in length from the cartilage between the epiphyses and the shaft near the extremities. The medullary cavity is at first solid and grows by absorption of the cancellous tissue by the giant cells, or osteoblasts.

Flat bones grow in thickness from the periosteum and in surface from the borders. Short bones grow from the centre or centres of ossification in all directions.

THE CRANIAL BONES.

The cranial bones are eight in number:—

1 Frontal,	2 Temporal,
2 Parietal,	1 Sphenoid,
1 Occipital,	1 Ethmoid.

THE FRONTAL BONE forms the anterior portion of the cranium and consists of two portions, a vertical or frontal portion and a horizontal or orbito-nasal portion.

The vertical portion consists of two surfaces, external and internal.

The *external surface* is convex, and presents the *frontal eminence* on either side of the median line, the *superciliary ridges*, produced by the frontal sinuses, beneath, below which is the *supra-orbital arch*, forming the upper boundary of the orbit, and terminating on either side in the *external angular process*, articu-

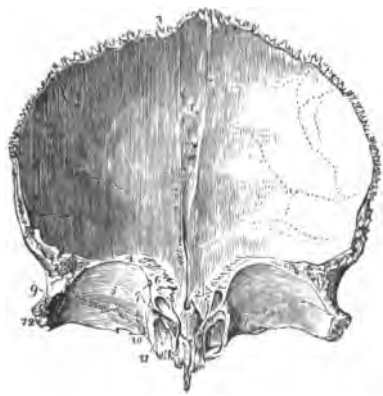

FIG. 2.

2, foramen cæcum; 4, articulates with lesser wing; 6, articulates with ethmoid; 7, anterior and posterior ethmoidal foramina; 9, lachrymal fossa; 10, depression for pulley of superior oblique; 11, frontal sinus.

lating with the malar bone, and the *internal angular process*, articulating with the lachrymal bone, and having at its inner third a notch or foramen, the supra-orbital foramen, for passage of supra-orbital artery, nerve, and vein.

Ascending from the external angular process is the *temporal ridge* for attachment of temporal fascia. Between the internal angular processes is the *nasal notch*, for articulation with the nasal bone, and nasal process of superior maxilla, terminating below in the *nasal spine*, and above it projects the *nasal eminence*, or glabella, marking the location of the frontal sinuses.

The posterior or *internal surface* is concave and lodges the anterior lobes of the brain.

In the median line is the *frontal crest,* which gives attachment to the falx cerebri and terminates below in a foramen, the foramen cæcum, for passage of a small vein from the nose to the longitudinal sinus. The crest is grooved for longitudinal sinus, and has on either side of it depressions for the Pacchionian bodies. This surface is also grooved for anterior meningeal arteries.

The horizontal portion consists of an external and internal surface.

The *external surface* is concave, to form the roof of the orbit, and separated from the opposite side by the ethmoidal notch.

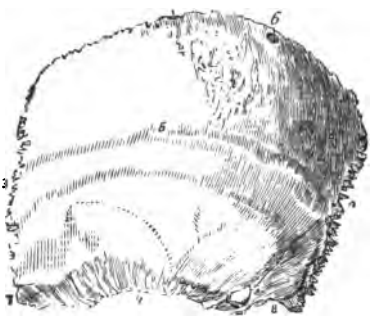

FIG. 3.

1, Superior border; 2, inferior border for squamous portion of temporal; 3, anterior border for frontal bone; 4, posterior border for occipital; 5, parietal eminence; 6, parietal foramen; 7, anterior inferior angle.

To the outer side is a *deep depression* for the *lachrymal gland,* and to the inner side a slight one for the *pulley* of superior oblique.

On the margin of the orbital plate are two notches converted into foramina by articulation with the ethmoid, the *anterior ethmoidal canal,* for passage of nasal nerve and anterior ethmoidal vessels, and the *posterior ethmoidal canal,* for passage of posterior ethmoidal vessels.

The *internal surface* is marked by the convolutions of the anterior lobes of the brain.

Between the two plates of the vertical portion are the frontal sinuses, two irregular cavities lined with mucous membrane and opening into the middle meatus of the nose on either side by the infundibulum.

It articulates with twelve bones, two parietal, sphenoid, ethmoid, nasal, superior maxillary, lachrymal, and malar.

Its muscular attachments are three pairs, corrugator supercilii, orbicularis palpebrarum, and temporal.

It is developed from membrane by two ossific centres, one for each lateral half.

PARIETALS.—These are two quadrilateral bones forming the superior and lateral walls of the cranium. Each bone consists of two surfaces, four borders, and four angles.

The *external surface* is convex and presents the *parietal eminence* a little above the middle, marking the original centre of ossification, the *temporal ridge,* crossing about the centre for attachment of the temporal fascia, and the *parietal foramen,* near the superior border or sagittal suture, for passage of a vein to the longitudinal sinus.

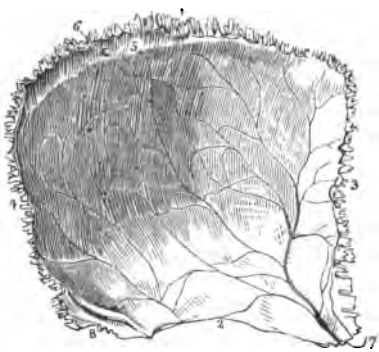

FIG. 4.

1, 2, 3, 4, superior, inferior, anterior, and posterior borders; 5, superior longitudinal sinus; 6, parietal foramen; 7, anterior inferior angle.

The *internal surface* is concave, and presents *furrows* for the branches of the meningeal arteries, *depressions* for cerebral convolutions, and Pacchionian bodies;

A *half groove* along the superior border for longitudinal sinus, and

A *groove* near the posterior inferior angle for the lateral sinus.

The *superior border* articulates with its fellow of the opposite side, forming the sagittal suture;

The *inferior border* articulates from before backward with the sphenoid, squamous, and mastoid portions of temporal bones;

The *anterior border* forms with the frontal bone the coronal suture, and

The *posterior border* forms with the occipital bone the lambdoid suture.

Of the angles the anterior inferior is the only important one, being longer and grooved internally by the middle meningeal artery.

It articulates with five bones—frontal, sphenoid, temporal, occipital, and opposite parietal bones.

It has but one muscle attached—the temporal.

It is developed from an ossific centre.

THE OCCIPITAL forms the posterior inferior portion of the cranium. It presents two surfaces, four angles, and four borders.

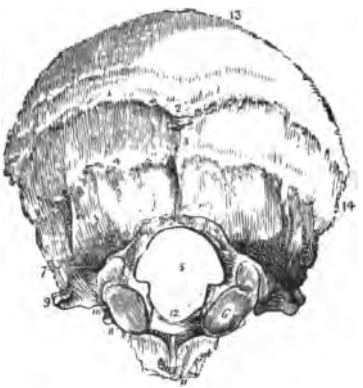

FIG. 5.

2, occipital protuberance; 3, crest; 4, inferior curved line; 5, foramen magnum; 6, condyle; 7, posterior condyloid foramen; 8, anterior condyloid foramen; 9, jugular process; 11, basilar process; 12, tubercles for check ligaments.

The *external* and *posterior surface* is irregularly convex, and presents

The *occipital protuberance* (also called external to distinguish it), for insertion of ligamentum nuchæ, descending from which to the foramen magnum is

The *occipital crest,* for tendinous attachment, and diverging on either side, above and below, are

The *superior curved line,* for attachment of occipito frontalis, trapezius, and other muscles; and

The *inferior curved line* for attachment of rectus capitis posticus, major and minor.

Anteriorly it presents a large aperture,

The *foramen magnum,* transmitting the medulla oblongata and its coverings, the vertebral arteries, and the spinal accessory nerves.

A little in front and on either side of the foramen magnum are the condyles for articulation with the atlas, the inner border of each condyle presenting a *tubercle* for the check ligament.

Externally to each condyle are the *jugular processes,* affording attachment for the *rectus capitis lateralis,* and forming by its articulation with the fibrous portion of the temporal bone the *jugular foramen,* or *foramen lacerum posterius,* transmitting the internal jugular vein, glosso-pharyngeal, pneumogastric, and

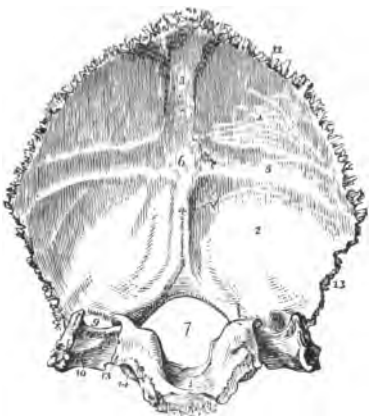

FIG. 6.

1, cerebral fossa; 2, cerebellar fossa; 3, superior longitudinal sinus; 4, occipital sinuses; 5, lateral sinus; 6, torcular Herophili; 7, foramen magnum; 8, jugular process; 9, posterior condyloid foramen; 13, jugular fossa; 14, inferior petrosal sinus.

spinal accessory nerves, and meningeal branches of the ascending pharyngeal and occipital arteries.

In front of the condyles on either side are the openings of the *anterior condyloid* foramen, for passage of hypoglossal nerve and meningeal branch from the ascending pharyngeal artery; and behind, the *posterior condyloid foramen,* for passage of a small vein to the lateral sinus.

In front of the foramen magnum is the *basilar process,* articulating with the sphenoid bone, and grooved on its under surface by the *pharyngeal spine* for the insertion of the tendinous raphé and superior constrictor of the pharynx.

The *internal surface* is irregularly concave and divided by a *crucial ridge,* or *occipital cross,* into four fossæ, the upper, for the posterior lobes of the cerebrum, and the lower, for the lateral lobes of the cerebellum. Its centre is marked by an eminence, the *internal occipital protuberance,* which is hollowed out to correspond to the *torcular Herophili,* or *confluence of the sinuses.*

The upper division of the crucial ridge affords attachment for the falx cerebri, being grooved for the great longitudinal sinus; the lower extremity, called also the *internal occipital crest,* affords attachment for the falx cerebelli, being grooved for the occipital sinus; and the lateral divisions afford attachment for the tentorium cerebelli and are grooved for the lateral sinuses.

The *internal* surfaces of the jugular processes are grooved for the lateral sinuses.

In front of the foramen magnum is the basilar groove, lodging the medulla oblongata and part of the pons Varolii. Its lateral borders (the basilar process) are grooved for the *inferior* petrosal sinus.

The *superior angle* articulates with the parietal bones, the *inferior angle* articulates with the sphenoid, and the *lateral angles* are wedged in between the mastoid portion of the temporal and the posterior inferior angle of the parietal.

This bone has four foramina—foramen magnum, anterior and posterior condyloid, and foramen lacerum posterius.

It articulates with six bones—two parietal, two temporal, the sphenoid, and the atlas.

The muscular attachments are twelve (12): occipito-frontalis, trapezius, sterno-mastoid, complexus, splenius capitis, obliquus superior, rectus capitis, posticus major and minor, rectus lateralis, rectus anticus major and minor, and superior pharyngeus constrictor.

It is developed from seven (7) ossific centres: four for the tabular, or *supra-occipital,* or occipital portion proper; one for each condyloid, or *external occipital* portion, and one for the basilar, or *basi-occipital* portion.

TEMPORALS.—These are situated at the side and base of the cranium, and consist of three portions—the squamous, mastoid, and petrous.

The *squamous* portion is scale-like and overlaps the parietal bone. Its *external surface,* convex behind, concave in front, presents from before backward the following:—

The *zygoma,* or *zygomatic process,* an arched process of bone articulating with the zygomatic process of the malar bone, and affording attachment above to the temporal fascia and below

to the masseter muscle. It is connected to the body of the bone by three roots, the *anterior root* of which ends in the *eminentia articularis*, a process of bone in front of the glenoid cavity, and presents at its junction a *tubercle* for the external lateral ligament; the *middle root* terminates at the *Glaserian fissure*, and the *posterior root* forms the posterior portion of temporal ridge and gives attachment to the retrahens aurem.

The *glenoid fossa* is a marked depression hollowed out for articulation of the condyle of the lower jaw. It is bounded in

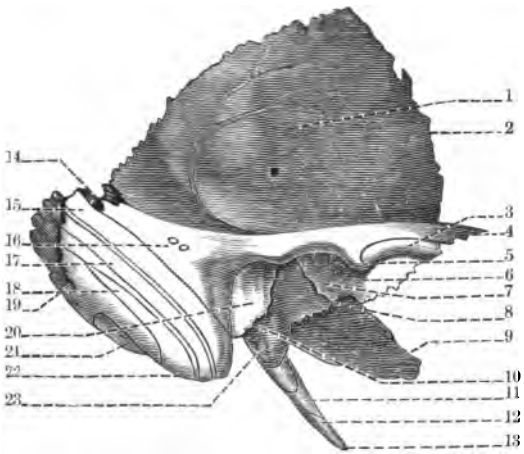

FIG. 7.

1, temporal fossa; 2, squamous portion; 3, for masseter muscle; 4, zygoma; 5, tubercle of zygoma; 6, eminentia articularis; 7, glenoid fossa; 8, Glaserian fissure; 9, petrous portion; 10, meatus auditorius externus; 11, stylo-hyoideus; 12, stylo-glossus; 13, styloid process; 14, mastoid portion; 15, sterno-mastoid; 16, retrahens aurem; 17, splenius capitis; 18, trachelo-mastoid; 19, mastoid foramen; 20, auditory process; 21, digastricus; 22, mastoid process; 23, vaginal process.

front by the eminentia articularis, to the outer side by the middle root, and behind by the *vaginal process*. It is divided into two portions by the Glaserian fissure, the anterior being separated from the auditory process by the *post-glenoid* tubercle—rudimentary in man—and the posterior being formed by the *tympanic plate*, a thin plate of bone forming the front wall of the tympanum.

The *Glaserian fissure* communicates with the tympanum, transmits the tympanic branch of the internal maxillary artery, and lodges the processus gracilis of the malleus.

In the angle between the squamous and petrous portions the chorda tympani nerve passes from the tympanum through the *canal of Huguier.*

The *internal surface* of the squamous portion presents the markings of the convolutions, and grooves for the ramifications of the middle meningeal artery. The *mastoid portion* is convex, rough, and nipple-like, and presents, externally, the following:—

The *mastoid foramen,* near the posterior border, transmits a branch of the occipital artery to the dura mater and a small vein to the lateral sinus;

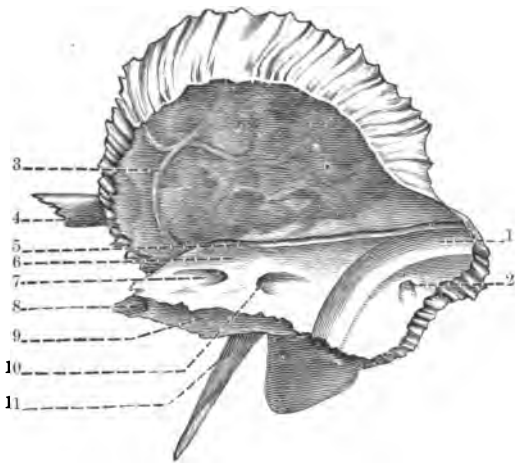

FIG. 8.

1, lateral sinus; 2, mastoid foramen; 3, middle meningeal artery; 4, zygoma; 5, superior petrosal sinus; 6, petrous portion; 7, meatus auditorius internus; 8, carotid canal; 9, aquæductus cochleæ; 10, aquæductus vestibuli; 11, stylo-pharyngeus.

The *mastoid process,* a prominent projection, composed of the *mastoid cells,* and affording insertion for the splenius capitis, sterno-mastoid, and trachelo-mastoid muscles.

To its inner side is a groove, the *digastric groove,* for attachment of the digastric muscle, and still more internally the *occipital groove,* for the accommodation of the occipital artery.

The internal surface is concave, and presents a groove, the *fossa sigmoidea,* for the lateral sinus, in the bottom of which is the opening of the *mastoid foramen.*

The *petrous portion* is pyramidal in shape, intensely hard, and contains the internal ear. It projects downward, forward, and inward, and presents for examination a superior, posterior, and inferior surface.

The *superior* or anterior surface is united to the squamous portion by the temporal suture and presents the following:—

An eminence, marking the position of the superior semicircular canal;

A *depression,* forming the roof of the tympanum;

The *hiatus Fallopii,* transmitting a branch of the middle meningeal artery and the petrosal branch of the Vidian nerve to the aqueduct of Fallopius;

Foramen for the smaller petrosal nerve;

Orifice of the *carotid canal,* transmitting the carotid plexus of the sympathetic and the internal carotid artery; and

Depression for Gasserian ganglion of the trifacial nerve.

The *posterior surface* presents about its middle

The *meatus auditorius internus,* at the bottom of which is the *lamina cribrosa,* a perpendicular plate of bone, and numerous foramina for the exit of the auditory nerve and the auditory branch of the basilar artery, one of which is the commencement of the aquæductus Fallopii for the facial nerve.

Posteriorly to the internal meatus is the *aquæductus vestibuli,* lodging a process of dura mater, and transmitting an artery and vein, and between them another small depression for the same purpose.

The *inferior* or *basilar surface* presents, from within outward, the following:—

A *rough, quadrilateral surface,* for attachment of the tensor tympani and levator palati muscles;

The *opening* of the *carotid* canal, transmitting the carotid plexus of the sympathetic and the internal carotid artery;

Aquæductus cochleæ, transmitting a vein to the internal jugular vein from the cochlea;

Jugular fossa, forming the jugular foramen (foramen lacerum posterius) by articulation with the occipital bone, and transmitting the internal jugular vein, the glosso-pharyngeal, pneumogastric, and spinal accessory nerves, and meningeal branches of the ascending pharyngeal and occipital arteries;

Foramen for *Jacobson's nerve,* the tympanic branch of the glosso-pharyngeal;

Foramen for *entrance* of *Arnold's nerve,* the auricular branch of the pneumogastric;

Jugular surface for *articulation* with *jugular process* on occipital bone;

The *vaginal process,* extending from the mastoid process to the carotid canal, and ensheathing

The *styloid process,* affording attachment for the stylo-maxillary and stylo-hyoid ligaments and the stylo-hyoideus, stylo-pharyngeus, and stylo-glossus muscles;

The *stylo-mastoid foramen,* for exit of facial nerve;

The *auricular fissure,* for the exit of Arnold's nerve, the auricular branch of the pneumogastric.

The *base* of the *petrous portion* presents

The *external auditory* meatus, the canal leading into the tympanum, and

The *auditory process,* a lamina of bone forming the greater part of its walls.

Borders.—The superior border affords attachment to the tentorium cerebelli, and has a groove for the superior petrosal sinus. The posterior border forms part of the jugular fossa. The anterior border articulates with the spinous process of the sphenoid. Between the squamous and petrous portions are two canals, separated by the *processus cochleariformis,* for the tensor tympani muscle above and the Eustachian tube below.

Muscular attachments are fifteen:—

To the squamous portion, 2—the temporal and masseter; to the mastoid portion, 6—sterno-mastoid, occipito-frontalis, splenius capitis, trachelo-mastoid, retrahens aurem, and digastricus; to the styloid portion, 3—stylo-hyoideus, stylo-pharyngeus, and stylo-glossus; and to the petrous portion, 4—levator palati, tensor palati, tensor tympani, and stapedius.

Its ossific centres are ten (10), 1 for the squamous portion, including the zygoma, 1 for auditory process, 6 for petrous and mastoid portions, and 2 for the styloid process.

THE SPHENOID is wedged in between the bones at the base of the skull anteriorly and resembles a bat with extended wings. It consists of

A body,
2 Greater wings,
2 Lesser wings, and
2 Pterygoid processes.

It presents

12 Foramina,
12 Articulations,
12 Pairs of muscles, and
14 Centres of ossification,

and is in every respect the most important bone of the cranium, entering into the formation of

5 Cavities—
1 Anterior cerebral,
2 Middle cerebral,
3 Orbital,
4 Pharyngeal,
5 Nasal,
4 Fossæ—
1 Temporal,
2 Zygomatic,
3 Spheno-maxillary,
4 Nasal, and
3 Fissures—
1 Spheno-maxillary,
2 Pterygoid-maxillary, and
3 Sphenoidal or foramen lacerum anterior.

The body is a hollow cube and presents upper, lower, anterior, and posterior surfaces.

The *upper surface* of the body presents from before backward the following points:—

Ethmoidal spine, for articulation with the cribriform plate of the ethmoid;

Optic groove, lodging the optic commissure and terminating in the optic foramen;

Olivary process, a small, olive-like eminence behind the optic groove;

Pituitary fossa, or *sella turcica,* for the pituitary body;

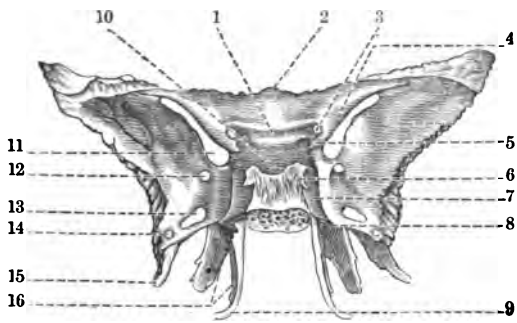

FIG. 9.

1, olivary process; 2, ethmoid spine; 3, optic foramen; 4, lesser wing; 5, anterior clinoid process; 6, posterior clinoid process; 7, carotid groove; 8, Vidian canal; 9, hamular process; 10, pituitary fossa; 11, sphenoidal fissure; 12, foramen rotundum; 13, foramen ovale; 14, foramen spinosum; 15, spinous process; 16, pterygoid process.

Middle clinoid process, one on either side bounding the pituitary fossa;

Dorsum sellæ, or dorsum ephippii, a quadrilateral plate of bone, bounding the pituitary fossa behind, and notched on either side for the passage of the sixth cranial nerves;

Posterior clinoid processes are the terminations of the dorsum sellæ on either side and afford attachment to the tentorium cerebelli;

Declivity, or *clivus Blumenbachii,* supporting the upper part of the pons Varolii;

Carotid or *cavernous groove,* lodging the cavernous sinus and the internal carotid artery;

Lingula, a ridge of bone to the outer side of the cavernous sinus.

The *lower surface* presents:—

Rostrum, the continuation downward of the ethmoidal crest, for articulation with the alæ of the vomer;

Vaginal processes, a thin plate of bone on either side articulating with the edges of the vomer; and

Groove, converted into the *pterygo-palatine* canal by articulation with the sphenoidal process of the palate bone for transmission of the pharyngeal nerve and pterygo-palatine vessels.

The *anterior surface* presents:—

Ethmoidal crest, a thin plate of bone articulating with the ethmoid;

Openings of *sphenoidal cells* or *sinuses* partially closed by the *sphenoidal turbinated bones* or *pyramids* of *Wistar,* two curved plates of bone absent in infancy but derived as a pair of cones from the ethmoid. The sphenoidal cells open into the

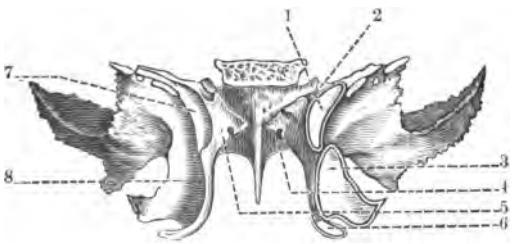

FIG. 10.

1, tensor palati; 2, Vidian canal; 3, pterygoideus internus; 4, pterygo-palatine canal; 5, vaginal process; 6, superior constrictor of pharynx; 7, scaphoid fossa; 8, pterygoid fossa.

superior meatus of the nose, but occasionally into the posterior ethmoidal sinuses.

The *posterior surface* articulates with the basilar process of the occipital and becomes united to it between the eighteenth and twenty-fifth year.

GREATER WINGS OF THE SPHENOID.

The *superior surfaces* of the great wing, deeply concave, forms part of middle fossa of skull and presents the following:—

Foramen rotundum, for second division of fifth nerve; *foramen ovale,* for third division of fifth, small meningeal artery, and small petrosal nerve; *foramen Vesalii,* for small vein, and *foramen spinosum,* for passage of middle meningeal artery.

The *exterior surface* is convex and presents:—

Pterygoid ridge, dividing the bone into two portions;

Spinous process, for attachment of tensor palati muscle, and the internal lateral ligament of the lower jaw.

The *anterior* or *orbital* surface enters into the formation of the orbit and presents numerous *external orbital foramina* for passage of branches of the deep temporal arteries.

The *circumference* of the greater wing forms part of the sphenoidal fissure and articulates with the frontal bone in front and laterally with the parietal, squamous, and petrous portions of the temporal bone.

The *lesser wings,* or *processes of Ingrassias,* project on either side from the superior surface of the body, to which they are attached by two roots.

The *upper surface* forms part of the anterior fossa of the skull. The lower surface forms part of the orbit and the upper border of the *sphenoidal fissure,* or *foramen lacerum anterius,* transmitting the third and fourth ophthalmic divisions of the fifth and sixth cranial nerves, orbital branch of the middle meningeal artery, a recurrent branch of the lachrymal artery, the ophthalmic vein, and filaments from the cavernous plexus.

The *anterior clinoid process* is formed by the inner extremity of the posterior border.

Between the two roots is the *optic foramen,* transmitting the optic nerve and ophthalmic artery.

The *pterygoid processes* are two wing-like processes descending from the junction of the greater wings with the body.

Each process presents the following:—

An *external pterygoid plate,* for attachment of the external pterygoid muscle;

The *pterygoid fossa* lies between the two plates and affords attachment for the internal pterygoid muscle;

The *internal pterygoid plate,* terminating below in a hook-like process—the *hamular process*—for the tendon of the tensor palati muscle;

The *scaphoid fossa,* at the base of the internal plate, affording origin for the tensor palati muscle and presenting just above it the posterior opening of the Vidian canal for the Vidian vessels and nerves;

An *angular interval* between the two plates articulates with tuberosity or pterygoid process of the palate bone.

THE FORAMINA are: Opticum, lacerum anterius, rotundum, Vesalii, ovale, spinosum, and two canals—Vidian and pterygo-palatine; articulate with twelve bones—two malar, two palate, vomer, and all of cranium. Its MUSCULAR ATTACHMENTS are twelve pairs—external and internal pterygoid, temporal, tensor palati, laxator tympani, superior constrictor, levator palpebræ,

obliquus superior; superior, inferior, internal and external recti. Its OSSIFIC CENTRES are fourteen, as follow: Body, 2 anterior and 2 posterior; external pterygoid plates and greater wings, 2; internal pterygoid plates, 2; lingula, 2; lesser wings, 2; sphenoturbinals, 2.

THE ETHMOID is a spongy, cubical bone, consisting of a perpendicular lamella, a horizontal or cribriform plate, and two lateral masses.

The *horizontal* or *cribriform plate* presents from before backward the following points:—

Two projections completing the *foramen cæcum,* the commencement of the longitudinal sinus;

Crista galli, affording attachment to the falx cerebri;

Foramina cribrosa, three rows, transmitting filaments of the olfactory body;

Fissure for passage of the nasal branch of the ophthalmic nerve.

The *perpendicular plate* assists in forming the nasal septum, articulating in front with the crest of the nasal bones and the frontal bone and behind with the sphenoid and vomer. It is usually inclined to one side.

The *lateral masses* are composed of the ethmoidal cells.

The *upper surface* presents two notches, converted into foramina by articulation with the frontal bone—

The *anterior ethmoidal foramen,* transmitting the anterior ethmoidal artery and nasal nerve, and

The *posterior ethmoidal foramen,* transmitting the posterior ethmoidal artery and vein.

The *outer surface* presents

The *os planum,* a smooth plate of bone forming the inner wall of the orbit, and projecting downward from it is

The *unciform process,* a hook-like plate of bone closing the upper part of the opening of the antrum.

The *inner surface* forms part of the nasal fossa, and presents

The *superior turbinated bone,* forming the upper boundary of the superior meatus, into which open the sphenoidal and posterior ethmoidal cells, and the

Middle turbinated bone, forming the upper boundary of the middle meatus of the nose, into which open the anterior ethmoidal cells, the frontal cells through the infundibulum, and the antrum Highmorianum.

It articulates with fifteen bones—two sphenoidal turbinated, sphenoid, frontal, and eleven of the face, the two nasal, two lachrymal, two superior maxillæ, two palate, two inferior turbinated, and the vomer.

It has no muscular attachments.

Its ossific centres are three—one for the lamella and one for each lateral mass.

BONES OF THE FACE.

The bones of the face are fourteen in number—six pairs and two single bones: Two lachrymal, two nasal, two malar, two superior maxillary, two palate, two turbinal, one vomer, and one inferior maxillary.

THE LACHRYMAL are two small, thin bones forming part of the inner wall of the orbit and the lachrymo-nasal duct, and named, from their resemblance to a finger-nail, the ossa unguis.

Each presents externally:—

The *lachrymal crest* affords attachment for the tensor tarsi and separates the anterior surface from the groove;

The *groove* forms part of the lachrymal groove and lodges the lachrymal sac;

The *hamular process,* or, when separate, called the *lesser lachrymal bone,* projects downward and articulates with the lachrymal tubercle of the superior maxilla.

Internally:—

A *furrow,* corresponding to the lachrymal crest on the external surface;

The *internal surface* enters into the formation of the middle meatus, closing in the anterior ethmoidal cells.

It articulates with four bones—the frontal, ethmoid, superior maxilla, and inferior turbinated.

The only muscular attachment is the tensor tarsi.

It is developed from one ossific centre.

THE NASAL bones are two irregularly quadrate bones forming together the bridge of the nose.

The *outer surface,* covered by the compressor nasi and pyramidalis muscles, presents

A *foramen,* transmitting a small vein.

The *inner surface* presents

A *groove* or *canal* for a branch of the nasal nerve.

The inferior border, the most important, has attached to it the lateral cartilage of the nose, and presents

A *spine,* forming, with its fellow, the *nasal angle,* a *notch* for exit of the branch of the nasal nerve which grooves the posterior surface.

It articulates with four bones—frontal, ethmoid, superior maxilla, and its fellow.

It has no muscular attachments. It is developed from one centre.

THE MALAR bones are two quadrilateral bones forming the prominence of the cheek. They enter into the formation of the orbit and the zygomatic and temporal fossæ.

Each bone has four processes—zygomatic, maxillary, frontal, and orbital.

The *external surface* has attached to it the zygomatic muscles (major and minor), and presents

A *foramen* to its outer side for the malar branch of the temporo-malar nerve and a foramen to its inner side for the temporal branch of the temporo-malar.

The *internal surface* articulates with the superior maxilla, has attached to it the masseter and temporal muscles, and presents the internal openings of the foramen given above.

FIG. 11.

1, malar process; 2, nasal process; 3, orbital process; 4, infra-orbital foramen; 5, infraorbital groove; 6, lachrymal tubercle; i, incisor teeth; c, canine; b, bicuspid; m, molars.

The *zygomatic process* forms, with the zygomatic process of the temporal bone, the zygoma.

The *maxillary process* is triangular and roughened for articulation with the superior maxilla.

The *frontal process* is articulated with the external angular process of the temporal bone.

The *orbital process,* the most important, articulates by its upper surface with the greater wing of the sphenoid, forming part of the outer wall of the orbit; the under surface forms part of the temporal fossa, while the posterior margin forms part of the spheno-maxillary fissure. The *superior surface* presents two temporo-malar canals, transmitting temporo-malar branches of the superior maxillary nerve.

It articulates with four bones—the frontal, sphenoid, temporal, and superior maxilla.

Its muscular attachments are five—the masseter, temporal, zygomaticus major and minor, and the levator labii superioris.

It is developed from one ossific centre.

THE SUPERIOR MAXILLA is the largest bone of the face, excepting the lower jaw, and one of the most important, assisting in the formation of three cavities, the mouth, nose, and orbit; two fissures, the spheno-maxillary and pterygo-maxillary; and two fossæ, the spheno-maxillary and zygomatic. It consists of a body and four processes—the nasal, the malar, the palatine, and the alveolar (Fig. 11).

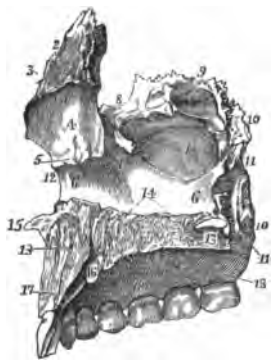

FIG. 12.

1, antrum; 2, nasal process; 3, superior turbinated bone; 4, middle meatus; 5, inferior crest; 6, inferior meatus; 11, posterior palatine canal; 15, anterior nasal spine; 16, anterior palatine canal; 18, palate process.

The body is excavated to form the *maxillary sinus* or *antrum Highmorianum,* a large, irregular triangular cavity, with its base directed inward, its apex upward and outward, projecting into the malar process.

Its posterior wall presents the *posterior dental canals,* transmitting the posterior dental vessels and nerves.

The *external* or *facial* surface (Fig. 11) of the body presents the following points:—

Incisive fossa, or *myrtiform fossa,* for the origin of the depressor alæ nasi:

Canine fossa, for origin of levator anguli oris;

Canine eminence, over the position of the canine tooth;

Infraorbital foramen, for the exit of the infraorbital nerve and artery.

The *internal surface* of the body presents:—

Palate process, separating the mouth from the nasal fossæ;

Orifice of antrum Highmorianum, before alluded to;

Groove completing the posterior palatine canals behind;

Deep groove in front, forming, with the inferior turbinated bone and lachrymal, the lachrymal canal for lachrymo-nasal duct;

Inferior turbinated crest for the turbinated bone.

The *superior orbital surface* presents:—

Infraorbital groove about the middle for the infraorbital artery and nerve;

Anterior dental canal, one of the divisions of the infraorbital canal, transmitting the anterior dental vessels and nerve.

The *posterior* or *zygomatic surface* presents:—

Posterior dental canals, transmitting posterior dental nerves and vessels;

Maxillary tuberosity, articulating with the tuberosity of the palate bone;

Groove, converted into posterior palatine canal by the palate bone for posterior palatine vessels and nerves.

The *nasal process* projects upward to articulate with the frontal bone, its external surface smooth, affording attachment to several muscles, its internal surface forming part of the outer wall of the nose. It presents the following:—

Superior turbinated crest, for the middle turbinated bone of the ethmoid;

Inferior turbinated crest below, for the inferior turbinated bone;

Groove at the posterior margin, forming part of the lachrymal canal;

Lachrymal tubercle, at the junction of the nasal process with the orbital surface.

The *malar process* projects upward and outward to articulate with the malar bone.

The *palatine process* projects from the internal surface of the bone to form part of the roof of the mouth and the floor of the nose. It presents:—

Anterior palatine canal or *fossa,* divided into four canals;

Foramina of *Stenson,* one on either side, transmit the anterior branch of the descending palatine artery;

Foramina of *Scarpa,* one in front and behind, transmit the naso-palatine nerves;

Suture in the anterior part showing original separation of the *incisive* or *intermaxillary bone;*

Posterior palatine groove for the posterior palatine vessels, and anterior palatine nerves from Meckel's ganglion;

Nasal crest for the vomer, and

Anterior nasal spine projecting from the anterior extremity of the crest.

The *alveolar process* forms the curved, spongy portion for the insertion of the upper teeth. It presents

The *alveoli* or *sockets* of varying depths, eight in the adult, five in the child.

It articulates with nine (9) bones—the ethmoid, frontal, lachrymal, nasal, malar, inferior turbinated, palate, vomer, and its fellow of the opposite side.

Its muscular attachments are nine—the levator labii superioris alæque nasi, levator labii superioris proprius, levator anguli oris, compressor naris, depressor alæ nasi, orbicularis palpebrarum, inferior obliquus, masseter, and buccinator.

FIG. 13.

1, horizontal plate; 2, vertical plate; 3, tuberosity; 4, crest; 5, post-nasal spine; 6, inferior turbinated crest; 7, spheno-palatine foramen; 8, zygomatic surface; 9, sphenoidal surface.

It is developed from four centres: one for incisive bone, or pre-maxilla; one for palate process, or pre-palatine; one for the maxillary portion, including the orbital and facial portion; and one for the malar portion.

EACH PALATE-BONE is a thin, L-shaped bone, consisting of an inferior or horizontal plate and a superior or vertical plate.

Each bone assists in forming three cavities—the outer wall and floor of the nose, the roof of the mouth, and floor of the orbit; two fossæ—the pterygoid and spheno-maxillary; and one fissure—the spheno-maxillary.

The *horizontal plate* is quadrilateral. Its *inferior surface* presents

A *ridge* for the aponeurosis of the tensor palati muscle;

A *groove* entering into the formation of the *posterior palatine canal;*

Accessory palatine foramina for posterior descending palatine nerves.

Its *posterior border* presents

The *posterior nasal spine* for the azygos uvulæ muscles.

The *internal border* articulates with its fellow and presents

A *crest* for the vomer.

The *vertical plate* projects upward and inward, terminating above in two well-marked processes—the *orbital* and *sphenoidal processes.*

The *internal surface* forms part of the outer wall of the nasal fossa, and presents

An *inferior turbinated* crest for the inferior turbinated bone;

A *superior* turbinated crest for the middle turbinated bone, separating the middle from the inferior meatus of the nose.

The *external surface* forms part of the spheno-maxillary fossa and covers part of the orifice of the antrum.

It presents at the posterior part

A *groove,* converted by the superior maxilla into a canal, the posterior palatine, for the passage of the descending palatine vessels and the descending palatine branches from Meckel's ganglion.

The *anterior* border presents

The *maxillary process,* closing part of the orifice of the antrum.

The *pterygoid process,* or tuberosity of the palate, at its lower part wedged in between the pterygoid plates of the sphenoid, and giving origin to part of the superior constrictor and the internal pterygoid muscles.

Foramina of *accessory descending palatine canals,* for posterior descending branches from Meckel's ganglion.

The ORBITAL PROCESS, a large, hollow, triangular process, is so called from its forming part of the orbit.

It presents

The *anterior* or *maxillary articular surface* for superior maxilla;

The *posterior* or *sphenoidal articular surface* for sphenoid;

The *internal* or *ethmoidal articular surface* for ethmoid;

A *superior* or *orbital surface,* a smooth portion entering into the formation of the orbit;

An *external* or *zygomatic surface,* also smooth, forming part of the zygomatic fossa.

THE SPHENOIDAL PROCESS is a small, thin plate of bone which articulates by its upper surface with the sphenoidal turbinated bone; its inner surface forms part of the nasal fossa, and its outer surface articulates with the pterygoid process of the sphenoid and forms part of the spheno-maxillary fossa.

The anterior border forms part of the *spheno-palatine foramen,* which passes between the orbital process and the sphenoidal process.

It articulates with six (6) bones—ethmoid, sphenoid, superior maxillary, vomer, inferior turbinated, and fellow of the opposite side.

Its muscular attachments are azygos uvulæ, tensor palati, internal and external pterygoid, and superior constrictor. It has one ossific centre at the junction of the plates.

THE INFERIOR TURBINATED BONES are small, scroll-like bones, situated on the outer wall of the nasal fossa, separating the middle from the inferior meatus. Each presents two surfaces and three processes, the lachrymal, ethmoidal, and maxillary.

The *internal surface* is lined in the recent state with the mucous membrane of the nose.

The *external surface* is attached to the superior maxilla and palate-bone, and presents above the three processes.

The *lachrymal process* forms part of the lachrymal canal, articulating with the superior maxilla and the lachrymal bone.

The *ethmoidal process* articulates with the hook-like process of the ethmoid bone.

The *maxillary process* projects outward and downward from the ethmoidal process, and narrows the orifice of the antrum.

It articulates with four bones—ethmoid, palate, superior maxillary, and lachrymal.

Muscular attachments, none. It has one ossific centre.

THE VOMER is a thin, triangular plate of bone, contributing to form part of the sæptum nasi. It is usually bent to one side.

The *superior border* presents a groove with overlapping laminæ, or *vaginal processes,* for articulation with the rostrum and vaginal processes of the sphenoid.

The *inferior border* articulates with the crests of the superior maxillæ and palate-bones.

The *posterior border* is smooth and free, forming the posterior nasal septum.

The *lateral surfaces* present

Furrows for blood-vessels, and

Naso-palatine grooves for the naso-palatine nerves, which descend to the foramina of Scarpa.

It articulates with six bones—the ethmoid, sphenoid, two palate, and two superior maxillæ.

It has no muscular attachments. It is developed from a single ossific centre, although it begins as two cartilaginous laminæ, which coalesce.

THE INFERIOR MAXILLA is the largest bone in the face. It consists of a body and two rami.

The body is the horizontal, horseshoe-like portion, containing the lower teeth.

The *external surface* presents from before backward:—

Symphysis, a vertical median line indicating the junction of the vaginal halves;

Mental process, a triangular prominence constituting the chin;

Incisive fossa, for the origin of the levator labii inferioris;

Mental foramen, for the exit of the mental nerve and artery;

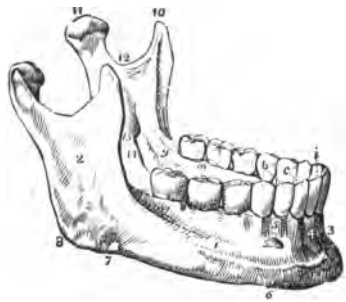

FIG. 14.

1, body; 2, ramus; 3, symphysis; 5, mental foramen; 6, external oblique line; 7, facial groove; 8, angle; 9, internal oblique line; 10, coronoid process; 11, condyle; 12, sigmoid notch; 13, inferior dental foramen; mylo-hyoid groove; i, incisors; c, canine; b, bicuspids; m, molars.

External oblique line, running backward and upward from the mental process, for the attachment of the depressor anguli oris and depressor labii inferioris.

The *internal surface* presents from before backward:—

Genial tubercles, four in number, for attachment of the genio-hyoglossi muscles above and the genio-hyoidei below;

Sublingual fossa, for the sublingual gland;

Internal oblique line (mylo-hyoidean), for the attachment of the superior constrictor, the mylo-hyoid muscles, and the pterygo-maxillary ligament;

Submaxillary fossa, for the submaxillary gland.

The *superior* or *alveolar* border presents sixteen cavities (ten in childhood) for the teeth.

The *inferior border* is grooved posteriorly for the facial artery.

The *ramus* or *horizontal portion* on either side is somewhat quadrilateral, and presents the following points:—

The *internal surface of ramus;*

Foramen of *inferior* dental canal, for inferior dental vessels and nerve;

Mylo-hyoidean groove, described above;

Spine, for attachment of the internal lateral ligament of the lower jaw.

The *upper border* is surmounted by two processes, the coronoid and the condyloid processes, separated by the sigmoid notch.

The *coronoid process* is in *front,* and affords attachment for the temporal muscle.

The *condyloid process* articulates with the glenoid fossa of the temporal bone, being supported upon a constricted portion, the neck, which receives the insertion of the external pterygoid muscle, and presents to its outer side a tubercle for the external lateral ligament of the lower jaw.

The *sigmoid notch* is crossed by the masseteric vessels and nerve.

The *lower border* presents:—

Angle of the jaw, the point of junction of the ramus with the body;

Rough surface, for attachment of the stylo-maxillary ligament, and on its inner side the internal pterygoid muscle, and on its outer side the masseter.

It articulates with the two temporal bones.

The muscular attachments are fifteen pairs; to the external surface, six—depressor anguli oris, depressor labii inferioris, levator labii inferioris, orbicularis oris, platysma myoides, and buccinator; from the internal surface of the body, five—the genio-hyoglossus, genio-hyoid, mylo-hyoid, digastric, and superior constrictor; and to the ramus, four—the masseter, internal and external pterygoids, and temporal.

It has two ossific centres, one for each lateral half, developed partly from membrane, partly from cartilage, being preceded in time only by one bone—the clavicle.

Changes in Lower Jaw.—Certain changes occur in the size and shape of the lower jaw as age advances.

At birth the body is shell-like, containing sockets for the ten temporary teeth, the mental foramen is large and opens beneath first molar, and the coronoid process is large and at right angles to base.

In adults the base and alveolar process are equal in size, the mental foramen opens midway between upper and lower borders, and the rami are at nearly right angles to base.

In advanced age the loss of the teeth and alveolar borders greatly reduces the body, the mental foramen opens near the alveolar border, and the rami are united at very obtuse angles with the base.

THE HYOID BONE, or lingual bone, is a small U-shaped bone situated at the base of the tongue, consisting of a body, two greater and two lesser cornua.

It is supported by the stylo-hyoid ligament from the styloid processes of the temporal bones.

The *anterior surface* is divided by a *crucial ridge* into four depressions for muscular attachments, and its centre presents a *tubercle.*

The *posterior surface* is in relation with the epiglottis, being separated by the thyro-hyoid membrane.

The *upper and lower borders* afford attachment to muscles, and the *lateral surfaces* are mounted with cartilage for articulation with the greater cornua.

The *greater cornua,* or thyro-hyals, project backward, afford attachment to the hyoglossus, thyro-hyoid, and middle constrictor of the pharynx, and terminate behind in a tubercle for the attachment of the thyro-hyoid ligament.

The *lesser cornua,* or cerato-hyals, are two tuber-like projections attached at the junction of the body with the greater cornua, and receiving the insertion of the stylo-hyoid ligaments. They do not articulate with any bone.

Its muscular attachments are ten—the lingualis, hyoglossus, genio-hyoglossus, middle constrictor, stylo-, mylo-, genio-, sterno-, thyro-, omo- hyoid; also aponeurosis of digastric and stylo-hyoid ligament.

Ossific centres, five—one for body and one for each horn.

THE SUTURES AND FONTANELLES.—The *sutures* are divided into three sets, those of the vertex, side, and base of the skull.

At the *vertex* of the skull there are three:—

Sagittal, or inter-parietal;
Coronal, or fronto-parietal;
Lambdoid, or occipito-parietal.

At the *side* of the skull are three:—

Spheno-parietal;
Squamo-parietal, or squamous;
Masto-parietal.

At the *base* of the skull are nine:—

Basilar, in centre,
Petro-occipital, } on either side.
Masto-occipital, }
Petro-sphenoidal, }
Squamo-sphenoidal, }

The sutures of the face are very numerous, but the most important are:—

Zygomatic, at the temporo-malar junction;
Transverse, passes from one external angular process to the other, and connects the frontal with the malar ethmoid, sphenoid, lachrymal, superior maxillary, and nasal bones;
Intermaxillary, the median suture between the superior maxillæ;
Symphysis, the remains of a fœtal suture.

The fontanelles are six membranous intervals in the infant's skull corresponding to the four angles of the parietal bones. The anterior, larger and lozenge-shaped, is at the junction of sagittal and coronal sutures; the posterior, smaller and triangular, is at the junction of sagittal and lambdoid sutures; and the four lateral are at anterior and posterior inferior angles of parietal bones.

The *Wormian,* or *supernumerary,* are irregular bones interposed in intervals between the cranial bones, chiefly in the course of the lambdoid suture. From their triangular form they are called "ossa triqueta."

Congenital fissures from an arrest of ossification also occur, the most common being the parietal and sagittal fissures (Treves).

FOSSÆ OF SKULL.

The fossæ at the lateral regior of the skull are temporal, zygomatic, and spheno-maxillary.

Temporal Fossa.—Deeply concave in front, convex behind, it is formed by parts of five bones—frontal, malar, sphenoid, temporal, and parietal. It is bounded above and behind by temporal ridge; in front by the sphenoid, malar, and frontal; below and externally by zygoma and pterygoid ridge on greater wing of sphenoid. It is crossed by six sutures—spheno-malar, spheno-parietal, squamo-parietal, squamo-sphenoidal, coronal, and transverse facial. It opens below into the zygomatic fossa, is filled by the temporal muscle, and lodges the deep temporal vessels.

Zygomatic Fossa.—This irregular cavity contains parts of temporal, external and internal pterygoid muscles, and is bounded above by pterygoid ridge of sphenoid and squamous portion of temporal, below by alveolar border of superior maxilla, in front by tuberosity of superior maxillary, behind by border of pterygoid process, externally by zygoma and ramus of lower jaw, and internally by external pterygoid plate. It is traversed by two fissures—spheno-maxillary and pterygo-maxillary.

The *spheno-maxillary fissure* connects the zygomatic, temporal, and spheno-maxillary fossæ, and transmits the infraorbital artery, ascending branches of Meckel's ganglion, the superior maxillary nerve, and its orbital branch.

It is bounded above by great wing of sphenoid, below by superior maxilla and part of palate bone; internally it opens into pterygo-maxillary fissure, and externally part of malar bone.

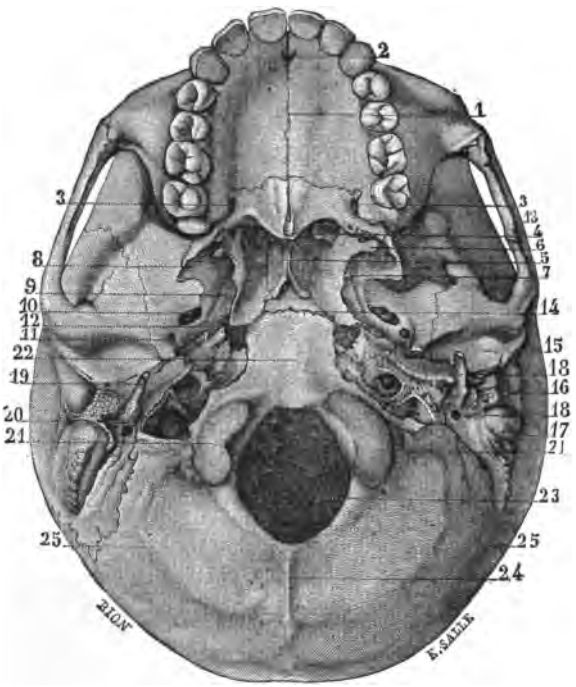

FIG. 15.

1, median suture; 2, anterior palatine foramen; 3, posterior palatine foramen; 4, posterior nasal spine; 5, vomer; 6, hamular process; 7, pterygo-palatine canal; 8, external plate; 9, scaphoid fossa; 10, foramen ovale; 11, foramen spinosum; 12, foramen lacerum medium; 13, zygoma; 14, basilar suture; 15, glenoid fossa; 16, external auditory meatus; 17, mastoid process; 18, styloid process; 19, carotid foramen; 20, foramen lacerum posterius; 21, occipital condyles; 22, basilar process; 23, foramen magnum; 24, occipital crest; 25, inferior curved lines.

The *pterygo-maxillary fissure* connects the zygomatic and spheno-maxillary fossæ, passing vertically between pterygoid process of sphenoid and superior maxillary bone, and transmits branches of internal maxillary artery.

The *spheno-maxillary fossa* is a triangular cavity, bounded above by body of sphenoid and orbital plate of palate-bone, within by vertical plate of palate, in front by superior maxillary, and behind by pterygoid process of sphenoid. It has communicating with it

Three fossæ—orbital, nasal, and zygomatic;

Three fissures—sphenoidal, spheno-maxillary, and pterygo-maxillary;

Two cavities—cranial and buccal; and

Five foramina—foramen rotundum, Vidian, and pterygo-palatine posteriorly; spheno-palatine, on inner wall, and posterior palatine canal, and (sometimes) accessory posterior pala-

FIG. 16.

2, nasal eminence; 3, supraorbital ridge; 4, lachrymal bone; 5, ethmoid bone; 6, infraorbital groove; 7, lachrymal groove; 9, infra-orbital foramen; 10, malar foramina.

tine canals below. It contains internal maxillary artery, superior maxillary nerve, and Meckel's ganglion.

THE ORBITS are two pyramidal cavities, situated between the nose and external angular processes, the forehead and face, their bases outward and forward, their apexes converging toward the body of the sphenoid bone. They contain the eye and its appendages, and are each formed by seven bones—frontal, ethmoid, sphenoid (entering into both cavities), and superior maxillary, lachrymal, malar, and palate (separate in each). The roof, concave, presents:—

Externally, depression for lachrymal gland;

Internally, depression for pulley of superior oblique, and

Posteriorly, a suture between lesser wing and frontal bone.

It is formed by the orbital plate of frontal and lesser wing of sphenoid.

The *floor* is short and flat, and presents:—

Internally, a depression for inferior oblique muscle;

Middle, the infraorbital groove for nerve and artery;

Externally, suture of superior maxillary and malar, and

Posteriorly, suture between palate and superior maxillary.

It is formed by orbital processes of malar and superior maxilla and orbital surface of palate.

Inner wall presents crest of lachrymal bone, lachrymal groove, and sutures between ethmoid and sphenoid, and ethmoid and lachrymal.

It is formed by lachrymal, parts of ethmoid, and sphenoid and nasal process of superior maxilla.

The *outer wall* presents suture between malar and sphenoid and orifices of malar canals. It is formed by orbital plate of sphenoid and orbital process of malar.

The *angles* of the orbit are four,—superior internal and external, inferior internal and external.

They present the following:—

Superior internal angle;

Foramen ethmoidal anterior, transmitting anterior ethmoidal vessels and nasal nerve;

Foramen ethmoidal posterior, transmitting posterior ethmoidal artery and vein;

Suture between frontal and ethmoid, and frontal and lachrymal;

Superior external angle;

Sphenoidal fissure, or *foramen lacerum anterius,* transmitting third, fourth, ophthalmic division of fifth and sixth nerves; orbital branch of middle meningeal artery, filaments of cavernous plexus of sympathetic, recurrent branch of lachrymal artery, and ophthalmic vein and process of dura mater.

Suture between great wing of sphenoid and malar bone.

Inferior internal angle;

Suture between superior maxillary and palate bones, uniting with lachrymal and os planum of ethmoid;

Inferior external angle;

Spheno-maxillary fissure, for passage of superior maxillary nerve and its orbital branch, infraorbital vessels, and ascending branches from Meckel's ganglion.

The CIRCUMFERENCE is bounded:—

Inner side by nasal process of superior maxilla and internal angular process of frontal;

Outer side by external angular process of frontal and malar bone;

Above by supraorbital arch;

Below by lachrymal, superior maxilla, and malar.

It presents *sutures malo-maxillary* below;

Sutures fronto-malar to outer side;

Sutures fronto-maxillary to inner side;

Supraorbital notch or *foramen* above, for passage of supraorbital nerve, artery, and vein, and forms part of lachrymal groove.

The *apex* presents:—

Optic foramen, for passage of optic nerve and ophthalmic artery.

Each *orbit* presents nine (9) openings, as follows:—

1. *Supraorbital* foramen for passage of supraorbital artery, vein, and nerve;

2. *Infraorbital* canal for infraorbital nerve and artery;

3. *Anterior ethmoidal foramen* for anterior ethmoidal artery, vein, and the nasal nerve;

4. *Posterior ethmoidal foramen* for posterior ethmoidal artery and vein;

5. *Malar foramina,* for malar and temporal branches of temporo-malar nerve;

6. *Lachrymal canal,* for lachrymo-nasal duct;

7. *Spheno-maxillary* fissure, for infraorbital vessels, superior maxillary nerve and its orbital branches, and ascending branches from spheno-palatine (Meckel's) ganglion;

8. *Foramen lacerum anterius* (or sphenoidal fissure), for third, fourth, ophthalmic division of fifth and sixth nerves, ophthalmic vein, branches of lachrymal and meningeal arteries, filaments of the sympathetic nerve, and a process of dura mater for ensheathing of the nerve;

9. Optic foramen, for optic nerve and ophthalmic artery.

THE NASAL FOSSÆ consist of two large cavities separated from each other by the *sæptum nasi,* and opening in front by the *anterior nares,* and behind into the pharynx by the *posterior nares.*

They are formed by fourteen bones—the frontal, ethmoid, sphenoid, and all the bones of the face except the lower jaw and malar.

They have each four sinuses opening into them—the ethmoidal and antrum of Highmore (maxillary) on either side, the sphenoidal behind and the frontal above, and communicate with the mouth by the anterior palatine canal, with the orbit by the

lachrymal canal, with the spheno-maxillary fossæ by the spheno-palatine foramen, and with the cranium by the olfactory foramina.

They are each bounded by an outer, inner, upper, and lower wall.

The *outer wall* is divided by the *middle* turbinated *process* of the *ethmoid* and the inferior turbinated bone into the *superior, middle,* and *inferior meatuses* of the *nose.*

The *superior meatus,* the smallest, has three orifices opening into it—

The posterior ethmoidal cells;

The sphenoidal sinuses, opening behind the superior turbinated bone, and

The spheno-palatine foramen, for transmission of spheno-palatine vessels and superior nasal and naso-palatine nerves.

The *middle* meatus has two orifices—

The *infundibulum,* communicating with the frontal sinuses, and through them with the anterior ethmoidal cells, and the orifice of the antrum or maxillary sinus.

The *inferior meatus,* the smallest, has two orifices—

The *lachrymal canal,* for lachrymo-nasal duct, and the *anterior palatine canals,* for anterior branches of descending palatine arteries (foramina of Stenson) and naso-palatine nerves (foramina of Scarpa).

The *inner wall,* or sæptum nasi, is formed by the vomer, vertical plate of the ethmoid, and the triangular cartilage of the nose, with portions of the following bones: nasal spine of the frontal, rostrum of the sphenoid, and the crests of the nasal, palate, and superior maxillary bones. It is grooved by the naso-palatine and other nerves.

The *upper wall* or *roof* presents the following from before backward:—

The *nasal slit* in the cribriform plate, for passage of nasal nerve, a branch of ophthalmic;

The *olfactory foramina,* for olfactory filaments, and

Openings or *orifices* posteriorly of the sphenoidal sinuses.

The *lower wall* or *floor* presents from before backward:—

The *anterior nasal spine;*

The *anterior palatine canals,* given above;

Crest or *ridge* for vomer;

Suture between superior maxillary and palate-bone, and

Posterior nasal spine.

FORAMINA AT THE BASE OF THE SKULL.

ANTERIOR FOSSA presents one single foramen and four in pairs:—

Foramen cæcum transmits a small vein to the superior longitudinal sinus;

Ethmoidal fissure transmits nasal branch of ophthalmic nerve;

Olfactory foramina, for filaments of olfactory bulb;

Anterior ethmoidal transmit anterior ethmoidal artery and nasal nerve;

Posterior ethmoidal transmits posterior ethmoidal artery and vein.

MIDDLE FOSSA presents nine (9) pairs:—

Optic foramen transmits the optic nerve and ophthalmic artery;

Foramen lacerum anterius, or sphenoidal fissure, transmits third, fourth, three branches of the (third) ophthalmic division of the fifth and sixth nerves, orbital branch of the middle meningeal, recurrent branch from the lachrymal artery, filaments of the sympathetic and ophthalmic vein;

Foramen rotundum transmits second division of fifth or superior maxillary;

Foramen Vesalii transmits a small vein;

Foramen ovale transmits third division of fifth or inferior maxillary nerve, small petrosal nerve, and small meningeal artery;

Foramen spinosum transmits middle or great meningeal artery;

Foramen lacerum medium transmits the internal carotid artery, carotid plexus, a branch of ascending pharyngeal artery, and the Vidian or large petrosal nerve;

Foramen for lesser petrosal nerve, and

Hiatus Fallopii transmits petrosal branch of middle meningeal artery and petrosal branch of the Vidian nerve.

POSTERIOR FOSSA presents six pairs and one single one:—

Meatus auditorius internus transmits auditory artery, facial and auditory nerves;

Aquæductus vestibuli transmits small artery and vein and lodges a process of dura mater;

Foramen lacerum posterius, or jugular foramen, transmits inferior petrosal sinus and lateral sinus, forming the internal jugular vein, glosso-pharyngeal, pneumogastric, and spinal accessory nerves, and meningeal branches of ascending pharyngeal and occipital arteries;

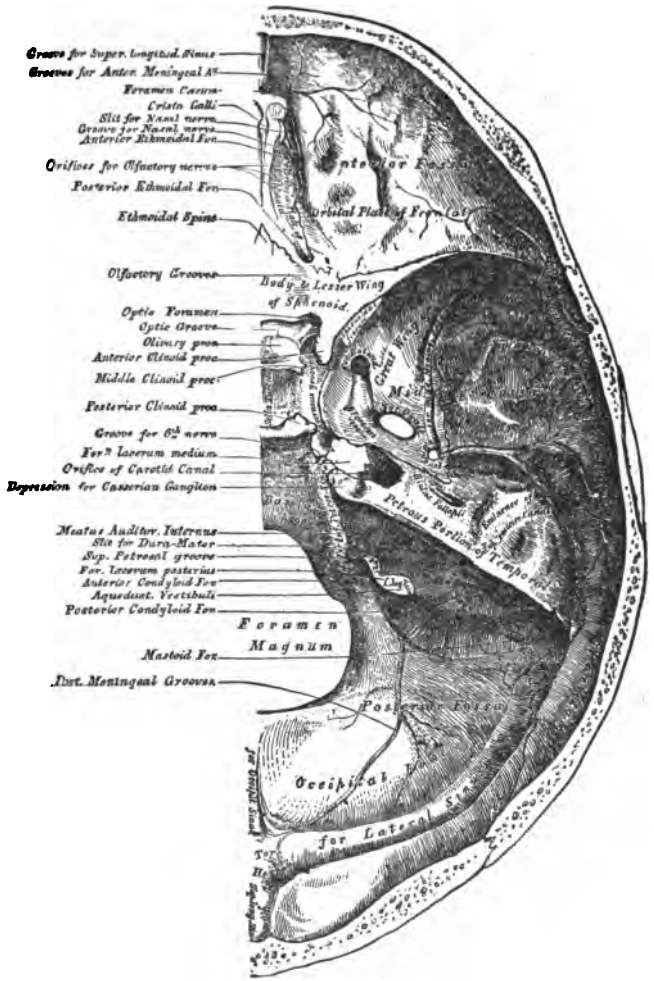

FIG. 17.

Floor of the cranium.

Mastoid foramen transmits small vein to the lateral sinus and small artery from occipital to the dura mater;

Anterior condyloid foramen transmits meningeal branch from ascending pharyngeal artery and hypoglossal nerve;

Posterior condyloid foramen transmits posterior condyloid vein;

Foramen magnum transmits vertebral arteries, medulla oblongata and its membranes, and the spinal accessory nerves.

OTHER FORAMINA OF SKULL.

The *external surface of the base* presents seven pairs:—

PALATAL PORTION:—

Incisive foramina transmit nerves and vessels to the incisor teeth;

Foramina of Stenson transmit the anterior branch of the posterior palatine vessels;

Foramina of Scarpa transmit the right and left naso-palatine nerve;

Posterior palatine foramina transmit posterior palatine vessels and descending palatine nerve;

Accessory palatine foramina transmit posterior palatine nerves;

Pterygo-palatine canals transmit pterygo-palatine vessels, and the

Pterygoid or *Vidian canal* transmits the Vidian artery and nerve.

LATERAL PORTION presents nine pairs:—

Opening of the Eustachian tube;

Opening of the tensor tympani canal transmits the tensor tympani muscle;

Glaserian fissure transmits the tympanic branch of the internal maxillary artery and lodges the processus gracilis of the malleus;

Canal of Huguier transmits chorda tympani nerve;

Foramen for Jacobson's nerve, the tympanic branch of the glosso-pharyngeal nerve;

Foramen for Arnold's nerve, the auricular branch of the pneumogastric nerve;

Opening of aquæductus cochleæ transmits a vein from the cochlea to internal jugular vein;

Auricular fissure transmits exit of Arnold's nerve;

Stylo-mastoid foramen transmits the facial nerve and stylo-mastoid artery.

ANTERIOR REGION presents three pairs:—

Supraorbital foramen, or notch, transmits supraorbital artery, vein, and nerve;

Infraorbital foramen transmits infraorbital artery and nerve, and

Mental foramen transmits mental nerve and artery.

BONES OF THE TRUNK.

THE STERNUM, or breast-bone, is a long, narrow, sword-like bone occupying the anterior part of the thorax and consisting of three portions: manubrium (handle), gladiolus (blade), xyphoid or ensiform appendix (point). Its anterior surface is irregularly flat, posterior surface slightly concave.

Manubrium is thick and triangular, and presents above the interclavicular notch, on either side of which are facets for articulation of clavicles. Laterally it presents an articular facet for the cartilage of the first rib and a half of one for part of second costal cartilage.

Gladiolus is the longest, narrowest portion, and presents about its centre, between the third and fourth segments, the *sternal foramen,* and laterally facets for half of the second and for the third, fourth, fifth, and sixth costal cartilages.

Ensiform appendix is cartilaginous in youth and varies much in size and shape.

It *articulates* with the clavicles and seven costal cartilages on side.

Its ossific centres are six—one each for the manubrium and appendix and four for the gladiolus, or body.

Its muscular attachments are ten—sterno-mastoid, sterno-hyoid, sterno-thyroid, pectoralis major, triangularis sterni, obliquus externus and internus, transversalis, rectus, and diaphragm.

THE RIBS, twelve on each side, form a series of narrow elastic arches on each side of the thorax, constituting the chief part of the thorax. They are divided into seven *vertebro-sternal, true* or *sternal,* each of which join the sternum by a separate costal cartilage; three *vertebro-chondral,* or *false,* the cartilages of which join each other and with the seventh before uniting with the sternum, and two *vertebral, free* or *floating,* which have no sternal attachment.

Each rib consists of a head, neck, tubercle, and body.

The *head* presents facet (except the first, tenth, eleventh, and twelfth) for articulation with the bodies of the contiguous

dorsal vertebræ, separated by a ridge for the interarticular ligament.

The *neck* or constricted portion is smooth in front and presents a *rough surface* behind for the middle costo-transverse ligament, and a *rough crest* above for the anterior costo-transverse ligament.

The *tubercle* or *tuberosity* (wanting in eleventh and twelfth) presents an articular surface for articulation with the transverse process of the vertebra below, and a non-articular surface for attachment of the posterior costo-transverse ligament.

The *shaft* or body is flat, thin, and twisted on itself. Its anterior extremity presents an *oval depression* for costal cartilage.

The *internal surface* is smooth, concave, and presents in front of the angle a *ridge,* forming the side of the groove on the inferior border.

The *external surface* is rough, convex, and presents a little in front of the tubercle a bend or *angle* marked by a prominent *line,* and near the sternal extremity another bend, the anterior angle, marked by an *oblique line.*

The *superior border* is round and thick, and presents an *external* and *internal lip* for external and internal intercostal muscles.

The inferior border at its posterior third presents a *groove* for the intercostal vessels and nerve, and at its anterior two-thirds is sharp and thin.

Peculiar Ribs.—The peculiar ribs are the first, second, tenth, eleventh, and twelfth.

The *first* is short, broad, and has no angle, and but one facet on the head. Its upper surface is marked by two parallel *grooves,* the anterior for the subclavian vein, the posterior for the artery, separated by a *tubercle* for insertion of scalenus anticus muscle,—an important guide in ligation of the subclavian artery.

The *second* resembles the first in being flattened and not twisted. The tubercle and angle are slight and almost coincide in position. The *outer surface* of the shaft presents near its middle a *rough eminence* for the second and third portions of the serratus magnus.

The *tenth* rib has but one facet for articulation with the tenth dorsal vertebra.

The *eleventh* has single facet on head, slight angle, but no tubercle or neck.

The *twelfth,* single facet, but no angle, tubercle, or neck.

The ribs articulate with twelve vertebræ behind and twelve costal cartilages in front.

Muscular attachments are twenty—scalenus anticus, medius, and posticus, pectoralis minor, intercostals, serratus magnus, obliquus externus, transversalis, quadratus lumborum, diaphragm, latissimus dorsi, serratus posticus, superior and inferior; sacrolumbalis, musculus accessorius ad ilio-costaleni, levatores costarum, longissimus dorsi, cervicalis ascendens, and infracostales.

They are developed from thirty-four ossific centres, each rib having one centre each for its head, shaft, and tubercle, except the eleventh and twelfth, which have but two centres, not having any tubercles.

VERTEBRÆ.

The SPINE, or *vertebral column,* is a flexible column composed of twenty-six bones (thirty-three vertebræ), as follows:

FIG. 18.

1, body; 2, demi-facet for rib; 3, superior articular processes; 5, intervertebral notch; 6, spinous process; 7, facet for tubercle on transverse process; 9, inferior articular processes.

seven cervical, twelve dorsal, five lumbar, sacrum, and coccyx. Each vertebra consists of a body, and an arch composed of two pedicles and two laminæ, supporting seven processes—one spinous, two transverse, and four articular.

The *body (centrum),* the large, solid, anterior portion, is generally half-cylindrical, concave behind, convex in front and sides. Its upper and lower surfaces are broad and rough, for attachment of interarticular cartilages. Its posterior surface has large foramen for exit of veins.

The *pedicles* project backward (except the cervical, which project obliquely outward), and present four *intervertebral notches,* two each, above and below. These, when articulated, form *interarticular foramina* for exit of spinal nerves and passage of blood-vessels.

The *laminæ* are two broad, flat plates of bone, projecting backward and inward from the pedicles, to complete the vertebral arch and inclose the spinal foramen. Their upper and lower margins are rough for attachment of the ligamenta subflava.

The *spinous processes* vary much in size and shape in the different regions. They project backward from the junction of the laminæ, and afford attachment for muscles.

The *transverse* processes project, one on each side, from the junction of the laminæ with the pedicles, and in the cervical region from the sides of the body also, inclosing the foramen for the vertebral artery.

The *articular processes,* four in number, project one above and below on each side, from the junction of the laminæ and pedicles. The two superior project upward and more or less backward, the inferior downward and more or less forward, articulating with the corresponding processes of the adjoining vertebra.

The *spinal foramen* is a large, triangular canal, inclosed by the body in front, the pedicles laterally, and the laminæ behind for the passage of the spinal cord and its membranes.

THE CERVICAL VERTEBRÆ are characterized by small body, concave above, convex below, the anterior margin overlapping the one below; short and bifid transverse process, perforated at base by foramen for vertebral artery; oblique articular processes —superior convex directed upward and backward, inferior concave downward and forward; short spinous process, bifid, placed horizontally; long and narrow lamina, inclosing large, triangular spinal canal.

The *peculiar cervical vertebræ* are first, second, and seventh.

The *first* or *atlas* is ring-like, without either body or spinous process, and consists of an anterior and posterior arch and two lateral masses. The anterior arch, convex in front, presents tubercle for longus colli muscles and behind articulates with odontoid process of axis. The posterior arch is deeply grooved above for transmission of vertebral artery and suboccipital nerves, and terminates behind in a rudimentary spine. It articulates above with condyles of occipital, below with axis. The transverse process is short and contains a foramen.

The *axis,* so-called from the pivot-like odontoid process, which projects from the upper part of its body to articulate with the anterior arch and transverse ligament of atlas.

The *seventh* resembles the dorsal series, its spinous process being long, not bifid, and prominent; hence its name, "vertebra prominens." To it is attached the ligamentum nuchæ.

THE DORSAL VERTEBRÆ have large, heart-shaped bodies, flat above and below. Laterally are demi-articular facets for heads of ribs; long, strong, transverse processes, marked by facet, for tubercle of rib; vertical articular processes, superior backward, inferior forward; long, triangular, overlapping spinous process; small, and nearly circular, spinal canal.

The *peculiar dorsal vertebræ* are: first, which resembles cervical, and have distinct facet for head of first rib, and half-one for half of second head; tenth, eleventh, and twelfth, one facet for head of rib; and eleventh and twelfth, no facet on transverse processes for tubercle of rib.

THE LUMBAR VERTEBRÆ are the largest, and have transversely oval body, flat above and below; long, thin, transverse processes, representing ribs; vertical processes interlocking with adjacent vertebræ; large, triangular spinal canal.

The *last lumbar* is *peculiar* in having body thicker in front, shorter and stronger transverse process, and inferior articular processes wider apart, and directed forward.

Muscular attachments *to atlas,* ten—rectus anticus minor, rectus lateralis, rectus posticus minor, obliquus superior and inferior, splenius colli, levator anguli scapulæ, interspinous, and intertransverse. To *axis,* ten—the last five of preceding, and obliquus inferior, rectus posticus major, semi-spinalis colli multifidus spinæ, scalenus posticus, and transversalis colli.

To the remaining vertebræ are attached anteriorly ten (10) muscles, and posteriorly twenty-two (22) [*vide* Spinal Muscles, p. 107].

Development.—The ossific centres for each vertebra are three primary, one for the body and one for each side, and five secondary epiphyses, as follows: one for tip of each spinous and transverse process, and the remaining two are thin plates on articular surfaces.

The exceptions to this rule are: atlas, with two primary centres and one epiphysis; the axis, with three extra centres for odontoid process; the seventh cervical, with one extra centre for each transverse process, and the lumbar vertebræ, two additional centres for tubercles.

THE SACRUM is a large, wedge-shaped bone, base above, apex below, with expanded lateral masses and alæ, composed of five consolidated sacral vertebræ, and forming the posterior wall of pelvis.

The *base* articulates with the last lumbar vertebra. Its anterior edge forms the *promontory* or *sacro-vertebral angle,* on each side of which is a smooth triangular surface, the *ala.* Behind the articulating surface is the *sacral canal,* and on either side are the superior processes.

The *apex* is small and articulates with the coccyx.

The *anterior* concave *surface* presents four *ridges,* indicating the original separations, which terminate externally in eight *anterior sacral foramina,* with wide, shallow *grooves,* for the exit of the anterior sacral nerves. To the outer side of these foramina is the *lateral mass* for origin of pyriformis muscle.

The *posterior surface* presents rudimentary spinous articular and transverse processes, the laminæ of the last two segments being deficient.* On the other side of the spinous process is a broad, shallow concavity, the sacral groove, for the origin of the erector spinæ muscle, and external to the articular processes are four *posterior sacral* foramina for the exit of posterior sacral nerves.

The *lateral surfaces* have each a rough *articular surface* for articulation, with ossa innominata, and below presents a deep notch on each side of the apex, which is converted by articulation with the transverse process of the coccyx into the fifth sacral foramen, for exit of anterior division of the fifth sacral nerve.

The *sacral canal,* continuous above with the spinal foramen of the vertebræ, runs through the centre. Large and triangular above, small and flattened below, its lower posterior wall is deficient. It lodges the sacral nerves, and out of it pass the anterior and posterior sacral foramina.

It articulates with four bones,—two ossa innominata, last lumbar vertebra, and coccyx.

Muscular attachments are seven—iliacus, pyriformis, coccygeus, gluteus maximus, latissimus dorsi, multifidus spinæ, and erector spinæ.

Its *ossific centres* are thirty-five, as follows: bodies, including interarticular plates, three each (15); arches, two each (10); lateral masses, six (6); epiphyseal plates of lateral surfaces, four (4). Total, 35.

THE COCCYX is a small triangular bone, resembling a cuckoo's beak, and composed of four rudimentary vertebræ more or less co-ossified.

The base articulates with the sacral apex, being prolonged upward into two cornua to complete the fifth posterior sacral foramen for exit of posterior branch of fifth sacral nerve.

Laterally the base is prolonged into rudimentary transverse processes, completing with the notch of the sacrum the fifth anterior sacral foramina for exit of the anterior branch of fifth sacral nerve.

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* The articular processes of the fourth and fifth unite to form the sacral cornua for articulation with the cornua of the coccyx.

The *anterior* concave *surface* supports the rectum and gives attachment to levator ani muscle and anterior sacro-coccygeal ligament.

The *posterior* convex *surface* presents rudimentary, articular processes and transverse grooves.

The apex is rounded, occasionally bifid, or deviated to one side, and affords attachment to the levator ani and sphincter ani muscles.

The muscular attachments are coccygei, gluteus maximus, extensor coccygeus (occasionally present), levator and sphincter ani.

Its ossific centres are four—one for each segment.

THE UPPER EXTREMITY.

The upper extremity consists of the arm, forearm, and hand. It is attached to the trunk by the clavicle and contains

FIG. 19.

1, sternal extremity; 2, costal facet for first rib; 5, acromial extremity; 6, 6, deltoid muscle; 7, 7, trapezius muscle.

the following bones: Clavicle, scapula, humerus, radius, ulna, eight carpus, five metacarpus, and fourteen phalanges.

THE CLAVICLE, or collar- or key- bone, is a long bone, curved horizontally like the italic letter *f*, extending almost horizontally between the sternum and acromial process of scapula. Its inner two-thirds are cylindrical and convex in front, its outer third flattened from above downward and concave in front. It consists of a body, or shaft, and outer, or acromial, and inner, or sternal extremities.

The *shaft* presents in its outer third the following points:—

Superior surface, rough *impression* in front for deltoid muscle, rough *impression* behind for trapezius;

Anterior border, occasionally *deltoid tubercle* about the centre for attachment of deltoid;

Inferior surface, conoid tubercle at the posterior border for conoid ligament; *oblique line* extending outward and forward from this for attachment of trapezoid ligament.

The inner two-thirds is prismatic and presents three surfaces and three borders:—

Anterior surface, divided by *line* into upper rough surface for sterno-mastoid muscle and lower for pectoralis major;

Posterior or *cervical surface,* gives attachment to sterno-hyoid muscle and presents *foramen* for nutrient artery.

Inferior or *subclavian surface* presents:—

Facet, continuous with sternal articular surface, for cartilage of first rib;

Rhomboid impression for costo-clavicular or rhomboid ligament;

Subclavian groove for attachment of subclavian muscle;

Longitudinal line, frequently dividing the groove into two parts, for intermuscular septum of the muscle.

Anterior border separates the anterior and posterior surfaces and limits the attachment of the pectoralis major.

Superior border gives attachment to the sterno-mastoid muscle.

Posterior or *subclavian border* is short and concave, extending from the rhomboid impression to the conoid tubercle and giving attachment to the *subclavian fascia.*

The *acromial* extremity presents an *oval facet* for articulation with the acromial process of the scapula and a *rough circumference* for acromio-clavicular ligaments.

The *sternal extremity* is triangular, and presents a *facet* for cartilage of sternal articulation and *rough circumference* for sterno-clavicular ligaments.

The clavicle articulates with three bones—the sternum, scapula, and first costal cartilage.

The muscular attachments are seven—subclavius, platysma, sterno-hyoid, sterno-mastoid, trapezius, pectoralis major, and deltoid.

Its ossific centres are two—one each for body and sternal end.

THE SCAPULA, or shoulder-blade, is a large, flat, triangular bone situated on the upper postero-lateral aspect of the thorax from the second to seventh rib, inclusive.

It consists of a body, head, neck, acromion, and coracoid processes, and presents two surfaces, three borders, and three angles.

The *anterior surface,* or *venter,* presents:—

Subscapular fossa, a concave triangular surface for attachment of subscapular muscles, marked by

Oblique ridges, for the tendinous intersections of the muscle;

Marginal surface, for attachment of serratus magnus;

Subscapular angle, a transverse depression at the upper part for the thickest part of the muscle.

The *posterior surface,* or *dorsum,* presents:—

Spine, a bony ridge passing upward, forward, and outward, dividing it unequally into two fossæ, affording attachment to the trapezius muscle above and the deltoid below, and terminating above in the *acromion process;*

Supra-spinous fossa above the spine, for the origin of the supra-spinatus muscle;

Infra-spinous fossa below, for the origin of the infra-spinatus muscle;

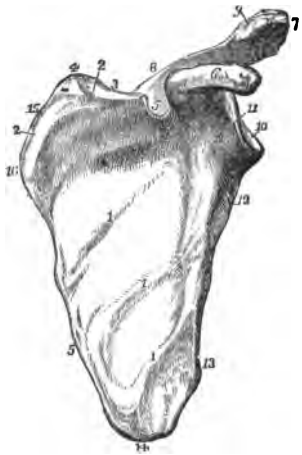


FIG. 20.

1, 1, 1, oblique ridges; 3, superior border; 4, superior angle; 5, supra-scapular notch; 6, coracoid process; 7, acromial process; 10, glenoid fossa; 14, inferior angle.

Nutrient foramen, near the upper part of infra-spinous fossa, for nutrient artery.

The *marginal surface* extends from the glenoid cavity downward and backward to an inch above inferior angle, its inner side formed by

An *elevated ridge,* for the attachment of the aponeurosis between the infra-spinatus and two teres muscles; its outer side by the axillary border. It is divided by an *oblique line* into two parts, the upper for the teres minor and the lower for the teres major muscles, and crossed by a *groove* near the upper part for the dorsalis scapulæ vessels;

A *smooth,* triangular *surface* at the root of the spine over which the trapezius glides.

The *superior border,* shortest, presents:—

Supra-scapular notch at the base of the coracoid process, converted into a *foramen* [supra-scapular] by the transverse ligament, for the passage of the supra-scapular nerve (the artery passing above);

Origin of omo-hyoid muscle from this border just internal to notch.

External or *axillary border,* thickest, presents:—

Rough impression, just below glenoid cavity, for origin of long head of triceps muscle, and below,

FIG. 21.

1, supra-spinous fossa; 2, infra-spinous fossa; 3, superior border; 4, supra-scapular notch; 5, axillary border; 6, head; 7, inferior angle; 8, neck; 9, vertebral border; 10, spine; 11, surface for trapezius; 12, acromion process; 13, nutrient foramen; 14, coracoid process.

Longitudinal groove, for origin of part of subscapularis.

Internal, vertebral border (base), longest, presents:—

Anterior lip, for insertion of serratus magnus;

Posterior lip, for attachment above of supra-spinatus, below infra-spinatus.

The *superior angle,* gives attachment to part of levator angulæ scapulæ;

The *inferior angle,* for attachment of teres major, and sometimes part of latissimus dorsi.

The *anterior* or *external angle* is thickest, and forms the head.

The *head* is connected to the body of the scapula by a constricted portion, the *neck,* from the anterior surface of which arises the coracoid process. It presents

The *glenoid cavity* or *fossa,* a shallow, pyriform, articular depression, deepened in the recent state by the glenoid ligament, for the head of the humerus. To its upper part or apex is attached the long head of the biceps muscle.

THE ACROMION PROCESS, forming the summit of the shoulder, is a triangular process, projecting forward, outward, and upward to overarch the glenoid cavity. It gives attachment by its upper surface to the platysma and deltoid and by its inner margin to the trapezius. It presents

An *apex,* for attachment of coraco-acromial ligament;

Articular facet, just behind the apex for the clavicle.

THE CORACOID PROCESS (like a crow's beak) arches forward, upward, and inward above the glenoid cavity. It presents:—

Attachment for pectoralis minor muscle from the anterior border near the tip;

Apex, for attachment of coraco-brachialis and short head of biceps;

Rough impression at the inner side of the root for the conoid ligament, and from it

A *ridge* running outward and forward for the trapezoid ligament.

It articulates with the clavicle and humerus.

Its muscular attachments are 18: platysma, supra- and infra- spinatus, subscapular, deltoid, trapezius, omo-hyoid, serratus magnus, levator anguli scapulæ, rhomboideus major and minor, triceps, teres major and minor, biceps, coraco-brachialis, pectoralis minor, and latissimus dorsi.

Its ossific centres are seven—one each for body, posterior border, and inferior angle, and two each for acromion and coracoid processes.

THE HUMERUS, or ARM-BONE, the largest and longest bone of the upper extremity, consists of a shaft, head, neck, greater and lesser tuberosities, and lower extremity.

The *shaft,* cylindrical above, flattened and prismoid below, becomes twisted in the middle, and presents

A *rough triangular surface* about the middle of its outer surface for insertion of the deltoid muscle, and a

Musculo-spiral groove for the musculo-spiral nerve and superior profunda artery, on each side of which arise the external and internal heads of the triceps muscle.

The *upper extremity* presents

The *head,* forming nearly a sphere, projecting upward, backward, and inward, articulating with the glenoid cavity;

The *anatomical neck,* immediately beneath, is slightly *grooved* for the attachment of the capsular ligament;

Greater tuberosity, external to the head and lesser tuberosity, with three facets from before backward for attachment of supra-spinatus, infra-spinatus, and teres minor muscles;

Lesser tuberosity, smaller but more prominent than greater, is anterior to head, for the subscapular muscle;

Bicipital groove, passes downward and inward between the two tuberosities and lodges the long tendon of biceps;

The *anterior bicipital ridge,* bounds the groove in front and receives insertion of pectoralis major muscle;

The *posterior bicipital ridge,* receives the latissimus dorsi and teres major;

The *surgical neck,* including the head, neck, and both tuberosities;

A *rough impression* near the centre of the inner border for the coraco-brachialis muscle;

Nutrient canal, below and directed toward the lower extremity.

The *lower extremity* presents from within outward the following:—

Internal condyloid ridge, extending upward from the condyle;

Internal condyle, more prominent than external, gives origin to the flexors and pronator radii teres;

Epitrochlea, an eminence separating the trochlea from the internal condyle;

Trochlea, a pulley-like articulating surface for greater sigmoid cavity of ulna;

Coronoid fossa, a small depression bounding the trochlea in front, and receiving the coronoid of the ulna in flexion;

Olecranon fossa, a larger depression behind, and receiving the olecranon process of ulna in extension;

Supra-trochlear foramen, sometimes formed by perforation of one fossa into the other;

Radial head, or *capitellum,* a smooth, rounded eminence articulating with cup-like depression on head of radius;

External condyle, less prominent, gives origin to the extensors and supinators;

External condyloid ridge, extending upward on the shaft from the condyle.

It articulates with three bones—scapula, radius, and ulna.

Its muscular attachments are twenty-five—subscapularis, supra- and infra- spinatus, teres major and minor, pectoralis major, latissimus dorsi, deltoid, coraco-brachialis, brachialis anticus, triceps, pronators and flexors to inner condyle, pronator radii teres, flexor carpi radialis, palmaris longus, flexor sublimus digitorum, flexor carpi ulnaris, supinators and extensors to outer condyle, supinator longus, extensor carpi radialis longior and

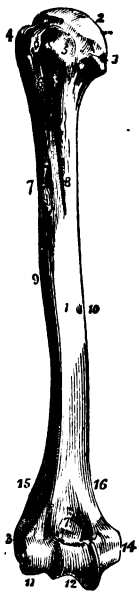


FIG. 22.

1, shaft; 2, head; 3, neck; 4, greater tuberosity; 5, lesser tuberosity; 6, posterior bicipital groove; 7, impression for deltoid; 8, bicipital groove; 10, nutrient foramen; 11, capitellum; 12, trochlea; 13, external condyle; 14, internal condyle; 15 and 16, external and internal supra-condyloid ridges.

FIG. 23.

1, shaft of ulna; 2, greater sigmoid cavity; 3, lesser sigmoid cavity; 4, olecranon; 5, coronoid process; 6, nutrient foramen; 7, interosseous borders; 8, head of ulna; 9, styloid process of ulna; 11, head of radius; 12, neck of radius; 13, tuberosity of radius; 14 shaft of radius; 15, carpal extremity of radius; 16, styloid process of radius.

brevior, extensor communis digitorum, extensor minimi digiti, extensor carpi ulnaris, anconeus and subanconeus, supinator brevis.

Its ossific centres are seven—one each for head, shaft, tuberosities, condyles, radial head, and trochlear portion.

THE ULNA is a long bone to the inner side of the forearm, and consists of a shaft and an upper and lower extremity. It forms the greater part of the articulation with the humerus, but

does not enter into the formation of the wrist-joint, being excluded by the interarticular fibro-cartilage.

The *shaft* is prismatic above, smooth and rounded below, and presents:—

Anterior surface, gives attachment to the deep flexors and pronator quadratus;

Nutrient foramen on anterior surface, directed upward toward the elbow-joint;

Posterior surface marked above by an *oblique line* for part of supinator brevis, above which is smooth triangular surface for anconeus muscle, and the lower third for extensor muscles of the thumb;

External border, sharp in middle two-thirds, for attachment of interosseus membrane.

The *upper extremity* is large and irregular, and presents:—

Olecranon process (head of elbow), projects upward and forward, its apex being received into the olecranon fossa of the humerus in extension of the forearm; its upper border has rough impression for the triceps muscle; its lateral borders are grooved for external and internal lateral ligaments;

Coronoid process, smaller than olecranon, projects forward from anterior surface, being received into coronoid fossa of humerus in flexion.

Its *upper surface* forms part of the great sigmoid cavity.

Its *under surface* has rough impression for insertion of brachialis anticus, and has, at its junction with the shaft, the *tubercle of the ulna* for the oblique ligament.

Its *outer surface* is the lesser sigmoid cavity.

Its *inner surface* gives attachment to the internal lateral ligament, and the flexor digitorum sublimis, flexor profundus digitorum, and one head of pronator radii teres.

Greater sigmoid cavity is a large, semi-lunar depression between the olecranon and coronoid processes, divided into two unequal lateral parts by an elevated ridge. It is continuous on the outer side with the lesser sigmoid cavity and articulates with the trochlear surface of the humerus.

Lesser sigmoid cavity is an oval, concave, articular depression, external to the coronoid process, for articulation with the head of the radius. Its prominent extremities give attachment to the orbicular ligament.

The *lower extremity* is small and cylindrical and presents:—

Head, an external, rounded, articular process, for the triangular fibro-cartilage below and the sigmoid cavity of the radius externally;

Styloid process, projects from the posterior and internal part of the extremity, its apex gives attachment to the internal lateral ligament of the wrist, and it is marked at its root by a depression between it and the head, for attachment of the fibro-cartilage;

Groove, upon the posterior surface, for passage of extensor carpi ulnaris.

It articulates with two bones—humerus and radius.

Its muscular attachments are sixteen—brachialis anticus, triceps, anconeus, flexor and extensor carpi ulnaris, pronator radii teres, flexor sublimus and profundus digitorum, pronator quadratus, supinator brevis, extensor indicis, extensor ossis metacarpi, extensor secundi internodii pollicis, and flexor longus pollicis.

Its ossific centres are three—one each for shaft, olecranon, and inferior extremity.

THE RADIUS is a long bone, shorter than the ulna, situated on the outer side of the forearm, the upper end small, the shaft slightly curved, and the lower end expanded to form part of the wrist-joint. It consists of shaft, upper and lower extremity.

The *shaft* is prismoid, slightly curved, and presents

An *internal border,* sharp and prominent, for interosseous membrane;

An *anterior border,* marked at its upper third by an *oblique line,* for attachment of flexor longus pollicis, supinator brevis, and flexor sublimis digitorum;

Anterior surface, affords attachment above for flexor longus pollicis, below for pronator quadratus, and presents at the junction of middle and upper two-thirds a *nutrient foramen* directed upward;

Posterior surface gives attachment at upper third to supinator brevis, and at middle third to extensors of thumb.

The *upper extremity* presents:—

Head—a cup-like cylindrical cavity, for articulation with capitellum of humerus, and on its side an articulating surface for lesser sigmoid cavity of ulna and orbicular ligament, which nearly surrounds it;

Neck, the constricted portion below the head;

Bicipital tuberosity, below and to inner side, divided by a vertical line into a rough surface posteriorly, for attachment of biceps tendon, and smooth surface anteriorly for bursa.

The *lower extremity,* large, expanded, and quadrilateral, presents:—

Carpal articular surface, smooth, concave, triangular depression divided by an antero-posterior ridge into an outer facet for scaphoid bone and inner for semi-lunar;

Sigmoid cavity, a shallow concavity at inner side of carpal end, for articulation with ulnar head;

Styloid process, projects obliquely downward from the external surface, for attachment by its apex to external lateral ligament of wrist-joint, and by its base to insertion of supinator longus muscle. Its outer surface is marked by two *grooves* for extensors of thumb;

The *posterior surface* of the lower extremity is also marked by three *grooves* from without inward for the following: ext. carpi radialis longior and brevior in first, ext. secundi internodii in second, and ext. indicis, ext. communis digitorum, and ext. minimi digiti in third innermost. This surface has also attachment of posterior ligament of wrist.

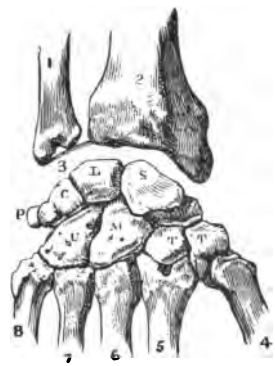


FIG. 24.

1, ulna; 2, radius; 3, fibro-cartilage; 4, 5, 6, 7, 8, metacarpal bones; S, scaphoid; L, semi-lunar; C, cuneiform; P, pisiform; R, trapezium; T, trapezoid; M, os magnum; U, unciform.

It articulates with four bones—humerus, ulna, scaphoid, and semi-lunar.

Its muscular attachments are nine—biceps, supinator longus and brevis, flexor digitorum sublimis, flexor longus pollicis, pronator quadratus, extensor ossis metacarpi pollicis, ext. primi internodii pollicis, and pronator radii teres.

Its ossific centres are three—one each for shaft and each extremity.

THE HAND.—The bones of the hand consist of eight carpus, five metacarpus, and fourteen phalanges; total, twenty-seven bones.

The carpus consists of eight small bones arranged in two rows—first, or proximal row, from the radial side inward are

scaphoid, semi-lunar, cuneiform, and pisiform; the second, or distal row, in same order are trapezium, trapezoid, os magnum, and unciform.

SCAPHOID (boat-shaped), largest of first row, convex above, concave below, articulates with five bones, as follows: superior surface, with radius; inferior, with trapezium and trapezoid; internal, with semi-lunar above and os magnum beneath. The external surface has attachment of external lateral ligament of wrist.

SEMI-LUNAR (half-moon), crescentic in outline, presents articulating surfaces for five bones, as follows: superior convex surface with radius, inferior concave facet with os magnum and unciform, quadrilateral internal facet with cuneiform, and external with scaphoid.

CUNEIFORM is wedge-shaped, the base, directed outward, articulates with the semi-lunar, apex with the interarticular fibrocartilage of wrist-joint, inferior surface with unciform, and anterior with pisiform; in all, three bones.

PISIFORM (pea-like) is a small, pea-shaped bone articulating with anterior surface of cuneiform, and affording attachment to annular ligament and two muscles, flexor carpi ulnaris, abductor minimi digiti.

TRAPEZIUM (a table), a very irregular bone, articulates above by concave surface with scaphoid; below, by surface concave from side to side, convex from before backward, with first metacarpal, by internal surface with trapezoid, inferior with second metacarpal. Its dorsal surface is rough; its palmar grooved by flexor carpi radialis tendon. Muscular attachments are three—flexor ossis metacarpi, flexor brevis pollicis, and abductor pollicis.

TRAPEZOID, smallest of second row, is wedge-shaped, apex palmar; articulates with four bones—superior surface with scaphoid, inferior with second metacarpal, external with trapezium, internal with os magnum and interosseous ligament.

It has one muscular attachment for flexor brevis pollicis.

OS MAGNUM, OR CAPITATE, the largest carpal bone, consists of a body, neck, and *head*. The latter projects from the superior surface and articulates with the scaphoid and semi-lunar. The inferior surface articulates with second, third, and fourth metacarpal bones; the external with trapezoid, and internal with unciform; in all seven bones.

Muscular attachment for flexor brevis pollicis.

UNCIFORM (hook-like), a wedge-shaped bone, so named from the hook-like process, projecting from its anterior surface, below its articulation with fourth and fifth metacarpals, and

above its articulation with semi-lunar. This process gives attachment to annular ligament, flexor brevis minimi digiti, flexor ossis metacarpi minimi digiti, and is grooved for passage of other flexor tendons. External surface articulates with os magnum and internal with cuneiform.

Muscular attachments are those to unciform process. Each carpal bone is developed from a single ossific centre.

Table of Articulations of Carpal Bones.—Scaphoid, five; semi-lunar, five; cuneiform, three; pisiform, one; trapezium, four; trapezoid, four; os magnum, seven; unciform, five.

THE METACARPUS are five long bones, resembling each other, and presenting a shaft and two extremities. Anterior surface is concave, posterior convex; superior extremity irregular for articulation with carpal bones and with the adjoining bones; inferior extremity presents rounded head for articulation with phalanges. The *first metacarpal* for thumb is supported on trapezium, articulates with first phalanx, and has three muscles attached—first dorsal interosseus, flexor, and extensor ossis metacarpi pollicis; the *second metacarpal* by three, trapezium, trapezoid, and os magnum, articulates also with third metacarpal and second phalanx, and has five muscles attached—first and second dorsal interosseus, first palmar interosseus, flexor carpi radialis, and extensor carpi radialis longior; the *third metacarpal* supported by os magnum, articulates also with second and fourth metacarpal and third phalanx, and has five muscles attached—flexor brevis pollicis, extensor carpi radialis brevior, adductor pollicis, and second and third dorsal interosseus. The *fourth metacarpal* is supported on os magnum and unciform, articulates with third and fifth metacarpal and fourth phalanx, and has three muscles attached—second palmar and third and fourth dorsal interosseus. The *fifth metacarpal,* supported on unciform, articulates with fourth metacarpal and fifth phalanx, and has five muscles attached—flexor ossis metacarpi minimi digiti, flexor and extensor carpi ulnaris, and fourth dorsal and third palmar interosseus.

Ossific centres are two for each bone, one each for shaft and head, except thumb, which has one each for shaft and base, resembling the phalanges.

PHALANGES.—Each finger has three phalanges, except the thumb, which has but two. Palmar surface concave, dorsal convex; the superior extremity articulates with head of metacarpal, and the inferior, concave from side to side, convex from before backward, articulates with second phalanx, which presents an opposite arrangement, except in the thumb, where it articulates with ungual or terminal phalanx.

The second phalangeal articulation is the same, and the ungual phalanx presents a rough, arrow-shaped extremity.

The muscular insertions to the *first row* are: to thumb four, flexor brevis, abductor and adductor pollicis, and extensor primi internodii; to index two, first palmar and dorsal interosseus; to middle two, second and third dorsal interossei; to ring two, second palmar and fourth dorsal interosseus; to little three, flexor brevis and abductor minimi digiti and third palmar interosseus.

The insertions to *second row* are: extensor secundi internodii and flexor longis pollicis; and to each of the others four, extensor communis digitorum, flexor sublimis digitorum, with the addition of extensor indicis to index and extensor minimi digiti to little.

The insertions to *third row* are: extensor communis digitorum and flexor profundus.

Ossific centres are two for each bone, one each for shaft and base.

THE LOWER EXTREMITY.

The lower extremity consists of the thigh, leg, and foot. It is connected to the trunk by the haunch, or hip-bone, and contains the following bones: os innominatum, femur, patella, tibia, fibula, seven tarsus, five metatarsus, and fourteen phalanges.

THE OS INNOMINATUM, or hip-bone, is a large, irregular bone forming the lateral and anterior walls of the pelvis, and consisting of three bones, ilium, ischium, and pubes, united about puberty. It presents

The *acetabulum* or *cotyloid cavity,* a deep, cup-shaped cavity, for articulation of the head of the femur—the ischium forming a little more than two-fifths, the ilium a little less than two-fifths, and the pubes one-fifth. The bottom of the cavity presents a circular depression, lodging a mass of fat, and giving attachment by its edges to the ligamentum teres, and continuous below with a deep notch, the *cotyloid notch,* for attachment of cotyloid and part of ligamentum teres, converted into a foramen by the transverse ligament for the entrance of the nutrient vessels and nerves. The margin of the acetabulum is deepened by a fibro-cartilaginous ring.

The *obturator,* or *thyroid foramen,* is an aperture large and ovoidal in the male, small and triangular in the female, situated on the anterior inferior surface between the ischium and pubes. It is closed, in the recent state, by a strong membrane attached to its margins except above externally, where a foramen exists for obturator vessels and nerve.

THE ILIUM, broad, flat, and triangular, forms the greater part of the bone, its base above, its apex at the acetabulum.

The *external surface,* or *dorsum,* concave in front and behind, presents from below upward

A *groove,* just above the acetabulum, for the reflected tendon of the rectus femoris muscle;

The *inferior curved line,* marking the lower border of the gluteus minimus;

The *middle curved line,* the longest of the three, marking the lower border of the gluteus medius; and

FIG. 25.

1, ilium; 2, ischium; 3, pubes; 4, crest of ilium; 5, 6, and 7, middle, inferior, and superior curved lines; 8 and 9, anterior superior and inferior spinous processes; 10 and 11, posterior superior and inferior spinous processes; 12, spine of ischium; 13, great sacro-sciatic notch; 14, lesser sacro-sciatic notch; 15, tuberosity of ischium; 16, ramus of ischium and pubes; 17, horizontal ramus of pubes; 19, acetabulum; 20, obturator foramen.

The *superior curved line,* the shortest marks the lower anterior border of the gluteus maximus, and from the surface below which arise a few fibres of the pyriformis.

The *upper* expanded *border* forms the *crest* of the *ilium,* terminating in front in

The *anterior superior spinous process,* giving origin to the sartorius and tensor vaginæ femoris muscles and Poupart's ligament, below which is

The *anterior inferior spinous process,* for the ilio-femoral ligament, and the straight tendon of the rectus femoris muscle; and behind in

The *posterior superior spinous process,* for the oblique band of the sacro-iliac ligament, and part of the multifidus spinæ muscle, below which is—

The *posterior inferior spinous process,* for attachment of the great sacro-sciatic ligament.

Between the superior and inferior spinous processes, both anteriorly and posteriorly, is a *notch,* the former for partial attachment of the sartorius and passage of the external cutaneous nerve.

The *internal* concave *surface,* or *venter,* presents

The *internal iliac fossa,* lodging the iliacus muscle, and having a nutrient foramen at its lower part;

Ilio-pectineal line, limiting the fossa below, and separating the false from the true pelvis;

Rough surface, divided into two parts—an upper part for posterior sacro-iliac ligaments, and lower *auricular surface* for articulation with sacrum.

THE ISCHIUM forms the outer back part of pelvis, and consists of a body, tuberosity, and ascending ramus.

The *external surface* of the body forms a little more than two-fifths of the acetabulum, and presents

A *groove* below, for the tendon of the obturator externus.

The *internal surface* is concave and smooth, and forms the lateral wall of the true pelvis.

The *posterior border* presents

The *spine* of the *ischium,* projecting downward, backward, and inward, from below the centre, for attachment of the gemellus superior, coccygeus, and levator ani muscles, and lesser sacro-sciatic ligament;

Great sacro-sciatic notch, a deep notch above the spine converted into a foramen by the lesser sacro-sciatic ligament, transmitting the pyriformis muscle, superior gluteal nerve, gluteal vessels, sciatic vessels and nerves, and the internal pudic vessels and nerves;

Lesser sacro-sciatic notch, below the spine, and between it and the tuberosity, converted into a foramen by the great sacro-sciatic ligament, transmitting the obturator internus muscle and nerve, the internal pudic vessels and nerves. The lowest portion of the body presents:—

Tuberosity (tuber ischii), with

An *outer lip,* for attachment of part of adductor magnus, and quadriceps femoris;

Inner lip, for part of great sacro-sciatic ligament, erector penis, and transversus perinæi;

Groove, on inner lip, for internal pudic vessels and nerve;

Intermediate surface, for semi-membranosus, semi-tendinosus, biceps, adductor magnus, gemellus inferior, and great sacrosciatic ligament.

The *ascending ramus* passes upward and inward from the tuberosity to join the descending ramus of the pubes, forming part of the inner margin of the obturator foramen. It gives attachment to gracilis, obturator externus, part of adductor magnus, erector penis, and transversus perinæi.

THE PUBES forms the anterior part of the pelvis, and consists of a body, horizontal ramus, and descending ramus.

The *body* is quadrilateral, and presents

An *anterior surface,* for attachment of adductor longus and brevis, and part of gracilis, adductor magnus, and obturator externus;

Posterior surface, forming anterior wall of true pelvis and giving attachment to levator ani and part of obturator internus;

Spine, upon the upper border, for Poupart's ligament and outer pillar of external abdominal ring;

Ilio-pectineal line, continuous with that on ilium;

Crest, along the upper border, internal to the spine;

Angle, at the junction of the inner border with the crest and giving attachment to internal pillar of external ring;

Symphysis, the internal oval border roughened by several ridges for articulation with opposite bone.

The *horizontal ramus* joins the ilium, forming the upper part of the obturator foramen, and presents at its lower border a

Groove, for the obturator vessels and nerve.

The *descending ramus* is flat and thin, and joins the ascending ramus of the ischium.

Each innominate bone *articulates* with three bones—the sacrum, femur, and its fellow of the opposite side.

Its muscular attachments are thirty-three—[ilium], latissimus dorsi, tensor vaginæ femoris, obliquus extensor, erector spinæ, transversalis, quadratus lumborum, gluteus minimus, medius, and maximus, rectus, pyriformis, iliacus, multifidus spinæ, sartorius; [ischium], obturator externus and internus, gemellus superior, coccygeus, levator ani, semi-membranosus and semi-tendinosus, biceps, quadratus femoris, adductor magnus, gemellus inferior, erector penis, and transversus perinæi; [pubes], pyramidalis, obliquus internus and externus, psoas parvus, pectineus, adductor longus and brevis, gracilis, and compressor urethræ.

Its ossific centres are eight—one primary for each division and five epiphyses, one each for crest of ilium, symphysis, tuberosity of ischium, anterior spinous process, and acetabulum.

THE FEMUR, or thigh-bone, is the largest, longest, and strongest bone in the body. In the erect position it inclines toward its fellow at the knee, being widely separated above, forming the sides of a triangle, the base of which is greater in females from the greater breadth of the pelvis. In consists of a shaft, an upper and lower extremity.

The *shaft,* expanded above and below, curved and twisted, convex in front, concave behind, is nearly cylindrical throughout, and presents:—

Smooth *anterior surface,* for origin of crureus and subcrureus muscles;

Lateral surfaces, covered by the vasti externus and internus;

The *posterior surface,* rough and prominent, has its

Nutrient foramen between the middle and lower two-thirds directed upward;

Linea aspera, a rough, prominent, longitudinal crest descending from the trochanters along the middle third, bifurcating and diverging at the inferior extremity to the condyles, inclosing

The *popliteal space,* a smooth, triangular space, on which rests the popliteal artery, and which is

Grooved at its inner margin by the femoral artery.

The *outer* and *inner lip* of the linea aspera give attachment to the vasti externi and interni, three adductors, pectineus, biceps, and gluteus maximus.

The *upper extremity* presents the following:—

The *head,* forming two-fifths of a sphere, articulates with the acetabulum, having a central oval depression for the ligamentum teres;

FIG. 26.

1, shaft of femur; 2, head; 3, neck; 4, great trochanter; 5, anterior trochanteric line; 6, lesser trochanter; 7 and 8, external and internal condyles; 10, groove for popliteus muscle; 9 and 11, external and internal tuberosities.

Neck, pyramidal, with excavated surfaces, connects the head with the shaft, the angle of its obliquity to the shaft varying much from puberty to old age, being, in the adult, about 130°;

The *great trochanter,* a large, rough, quadrilateral eminence, directed upward, outward, and backward, its external surface marked by a diagonal line for insertion of gluteus medius ten-

don, its outer surface smooth for the passage of the gluteus maximus tendon, separated by a bursa, and its superior surface marked by three impressions, from behind forward, for pyriformis, obturator internus, and gemelli muscles. The gluteus minimus is attached to the anterior border;

Digital or *trochanteric fossa,* to the inner side of the great trochanter, for insertion of obturator externus tendon;

The *lesser trochanter,* a small, conical projection at the base of the neck posteriorly, and giving attachment to the tendon of psoas magnus muscle, the iliacus being inserted below;

Anterior intertrochanteric line, connects the trochanters in front and gives attachment at its upper part to the capsular ligament;

Posterior intertrochanteric line, a much more prominent ridge, connects them behind;

Tubercle of the femur, a prominence at the junction of the neck with the great trochanter, is the meeting-place of five muscles—two gemelli, obturator internus, gluteus minimus, and vastus externus;

Tubercle of the quadratus, about the centre of the posterior intertrochanter line, for the quadratus femoris;

Linea quadrati, passes vertically downward from the middle of the posterior line, and gives attachment to part of adductor magnus and quadratus femoris.

The *inferior extremity,* large and cuboidal in form, presents:—

External condyle, shorter and broader than the internal, has behind its centre the *outer tuberosity* for the external lateral ligaments of the knee, and a *groove* below the tuberosity for the tendon of the popliteus muscle. It also gives origin to the outer head of the gastrocnemius, above which arises the plantaris muscle;

The *internal condyle,* longer by half an inch and more prominent (so as to bring them on the same horizontal plane owing to the obliquity of the shaft), has on the inner surface the *inner tuberosity* for the internal lateral ligament;

Adductor tubercle, at the summit of the internal condyle, marks the termination of the inner ridge of the linea aspera, and gives attachment to tendon of adductor magnus;

Depression, above the articular surface of the internal condyle posteriorly, for the origin of the inner head of gastrocnemius;

Intercondyloid notch, separates the condyles behind, and lodges the crucial ligaments;

Trochlea is a smooth surface between the condyles in front and articulates with the patella in front. The inferior surfaces of both condyles are smooth, continuous in front, covered with cartilage in the recent state, for articulation with the head of the tibia. The femur articulates with three bones—innominatum, tibia, and patella.

Its muscular attachments are twenty-three (23)—two vasti, three adductors, gluteus maximus, medius, and minimus, pyriformis, obturator externus and internus, two gemelli, quadratus femoris, psoas magnus, iliacus, biceps, pectineus, crureus, subcrureus, gastrocnemius, plantaris, and popliteal.

Its ossific centres are five—three primary, one each for shaft and each extremity, and one epiphysis for each trochanter.

THE PATELLA is a flat, triangular bone, sesamoid in origin, developed in the tendon of the quadriceps extensor, forming the knee-cap, and entering into the formation of the knee-joint.

The convex *anterior surface* is roughened by apertures for nutrient vessels.

The *posterior* or *internal surface* is divided by a vertical and transverse ridge into three surfaces—two smooth, articular *facets,* for either condyle of femur above, the outer being deeper and broader, and a rough surface below (apex) for ligamentum patellæ.

The *superior border* gives attachment to the rectus and crureus muscles, the internal and external lateral borders to the vasti internus and externus.

It articulates with the femur.

Its muscular attachments are four muscles—rectus femoris, crureus, vastus externus, and vastus internus.

It is developed from a single ossific centre.

THE TIBIA, or shin-bone, extends on the internal aspect of the leg from the knee to ankle, and consists of a shaft, upper and lower extremity.

The *shaft* is triangular, prismoid, with the base above.

Its *anterior border* and *internal surface* are subcutaneous, the former forming the *shin* or *crest of the tibia.*

The *posterior surface* presents above an *oblique line* for the lower border of the popliteal muscle and fascia, and origin of the soleus, and parts of flexor longus digitorum and tibialis posticus muscles.

It presents just below the oblique line a *nutrient canal,* the largest in the skeleton, directed downward.

Its *external border,* or *interosseous ridge,* is thin, for attachment of interosseous membrane.

The *external surface* and *internal borders* are covered by muscles.

The *superior* expanded *surface* presents:—

Head, consisting of two lateral *tuberosities,* having each upon their upper surfaces a smooth, concave, ovoidal articulating *facet* for the condyles of the femur, separated by

The *spinous process* of the tibia, in front and behind which is impression for crucial ligaments, and laterally tubercles for the extremities of the semi-lunar cartilages;

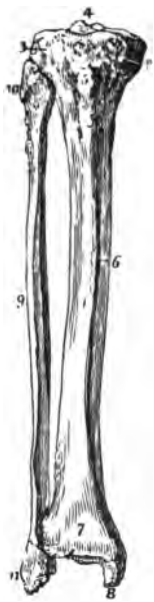


FIG. 27.

1, shaft of tibia; 2 and 3, inner and outer tuberosities; 4, spine; 5, tubercle; 6, crest or shin; 7, lower extremity; 8, internal malleolus; 9, shaft of fibula; 10, head of fibula; 11, external malleolus.

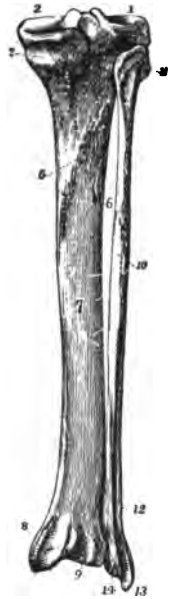


FIG. 28.

1 and 2, articular surfaces; 3, insertion of semi-membranosus; 5, oblique line; 6, nutrient foramen; 7, shaft of tibia; 9 and 14, grooves for flexors; 13, external malleolus.

Tubercle, on the anterior surface of the head, between the tuberosities, for the insertion of ligamentum patellæ;

Popliteal notch, separating the tuberosities posteriorly, for attachment of posterior crucial ligament;

Transverse groove, on the posterior surface of the inner tuberosity, for insertion of semi-membranosus tendon;

Facet, upon the posterior surface of the outer tuberosity, for articulation of the head of the fibula.

The *inferior extremity,* smaller than the superior, is quadrilateral, and presents in front a smooth surface for extensor tendons, behind a groove for flexor longus pollicis tendon, externally, a rough, triangular, articular surface, for fibula, and internally

The *internal malleolus,* which projects downward, and articulates by its outer surface with the astragalus.

Its inner surface is smooth and subcutaneous; its posterior border is grooved for the tendons of the tibialis posticus and flexor longus digitorum muscles, and to its tip is attached the internal lateral ligament.

It articulates with three bones—femur, fibula, and astragalus.

Its muscular attachments are twelve—ligamentum patellæ, popliteus, soleus, flexor longus digitorum, tibialis posticus, semimembranosus and tendinosus, gracilis, sartorius, tibialis anticus, and extensor longus digitorum, biceps.

It is developed from three ossific centres, one each for shaft, upper and lower extremities.

THE FIBULA, or peroneal bone, is a long, slender bone on the outer aspect of the leg, and consists of a shaft, upper and lower extremity.

The *shaft* is prismoidal, four-sided, twisted on itself, and arched backward. Its *antero-internal border,* or *interosseous ridge,* gives attachment to the interosseous membrane. The *postero-internal border,* called also *oblique line,* and the other surfaces and borders give attachment to all the muscles except the biceps.

Nutrient foramen, about the middle of the anterior internal surface, is directed downward.

The *superior extremity* presents a *neck,* supporting a rounded, irregular *head,* which articulates by a flattened *facet* on its inner surface with the tibia, and is prolonged upward on its outer side by the *styloid* process, giving attachment to the biceps tendon and the external lateral ligament of the knee.

The *inferior extremity* expands into the *external* malleolus, with its convex internal surface for articulation with astragalus, outer convex surface subcutaneous, and posterior border deeply *grooved* for tendons of peroneus longus and brevis muscles.

To the *summit* is attached the middle fasciculus of the external lateral ligament, and to rough *depressions* in front and behind the anterior and posterior fasciculi.

It articulates with two bones, tibia and astragalus.

Its muscular attachments are nine—soleus, biceps, three peronei, tibialis posticus, flexor longus pollicis, and extensor longus digitorum and pollicis.

It is developed from three ossific centres, one each for shaft, head, and malleolus.

THE FOOT.

The bones of the foot consist of seven tarsus, five metatarsus, and fourteen phalanges.

THE TARSAL BONES are—calcaneum, astragalus, cuboid, scaphoid, and internal, middle, and external cuneiform.

They may be arranged into two series, anterior and posterior, the calcis and astragalus behind, and all the others in front of the calcaneo-cuboid, astragalo-scaphoid joint [Chopart's].

CALCANEUM, or os calcis, the largest, is irregularly cuboidal.

The *superior surface* presents two articular surfaces for the astragalus, separated by a groove for the calcaneo-astragaloid ligament, and internally a projecting process, the *sustentaculum tali,* for calcaneo-cuboid ligament. The *inferior surface,* rough and excavated, presents two *tubercles,* an *outer* and *inner tubercle,* for muscles and ligaments.

Internal surface is concave, for passage of flexor longus, and tibialis posticus tendons, and plantar vessels and nerves.

External surface presents tubercle for external lateral ligament of ankle and grooves for peroneal tendons.

Posterior surface, projecting behind, presents a smooth surface above for bursa and rough below for attachment of tendo Achillis.

It articulates with astragalus and cuboid.

Muscular attachments are eight—tendo Achillis, plantaris, tibialis posticus, abductor pollicis and minimi digiti, flexor brevis, digitorum and accessorius, extensor brevis digitorum.

ASTRAGALUS is an irregular, short bone, consisting of body, neck, and head. The quadrilateral *body* presents four articular surfaces, above for lower extremity of tibia and internal malleolus and external malleolus; below two surfaces for os calcis, separated by deep groove for interosseous calcaneo-astragaloid ligament; *posteriorly* it presents a deep groove for flexor longus pollicis tendon; and *anteriorly,* the rounded convex *head* supported on *neck* articulates with scaphoid, and rests upon calcaneo-scaphoid ligament.

It articulates with four bones—tibia, fibula, scaphoid, and os calcis. It has no muscular attachments.

CUBOID (cube-like) is a small, pyramidal bone, between the os calcis and the fourth and fifth metatarsal bones on the outer side of the foot.

The *upper* or *dorsal surface* is rough for ligamentous attachment; the *lower* or *plantar* surface is *grooved* for tendon of pero-

neus longus, behind which is a *ridge* for the long calcaneo-cuboid ligament, terminating externally in the *tuberosity* of the *cuboid.*

The *external surface* has a deep *notch,* the outer extremity of the peroneal groove.

The *posterior surface* has triangular *facet* for os calcis, the anterior has two facets, separated by a ridge for the fourth and fifth metatarsals, and the internal surface has broad, square facet for external cuneiform, and sometimes a smaller facet for scaphoid.

FIG. 29.

1, os calcis; 2, 2, outer and inner tuberosity; 3, groove for flexor longus pollicis; 4, head of astragalus; 6, tubercle of scaphoid; 7, 8, 9, internal, middle, and external cuneiform bones; 10, cuboid; 11, groove for peroneus longus; 12, 12, metatarsal bones; 13, 14, 15, phalanges.

It articulates with four and occasionally with five bones.

It has one muscular attachment—part of flexor brevis pollicis.

SCAPHOID, or navicular bone, is a boat-like bone placed between astragalus and three cuneiform bones.

Its *posterior* concave *surface* articulates with head of astragalus, its *anterior* convex *surface* has three facets for cuneiform bones; its *internal border* presents the tuberosity of the scaphoid for insertion of tibialis posticus, the only muscular attachment. Its other borders are roughened for ligamentous attachment.

It articulates with four bones—astragalus and three cuneiforms.

The cuneiform bones are named from their position the internal, middle, and external.

THE INTERNAL CUNEIFORM, the largest, has its base below, and articulates anteriorly with first metatarsal, posteriorly with scaphoid, and externally with second metatarsal and middle cuneiform. The plantar surface presents tuberosity for insertion of part of tibialis posticus and anticus tendons, the only muscular attachments. It articulates with four bones—scaphoid, middle cuneiform, first and second metatarsals.

THE MIDDLE CUNEIFORM, the smallest, has its base upward, and articulates posteriorly with scaphoid, anteriorly by a triangular facet with second metatarsal, and laterally with internal and external cuneiforms. It has no muscles attached.

THE EXTERNAL CUNEIFORM, intermediate in size, and more regular, articulates posteriorly with scaphoid, anteriorly with third metatarsal, internally with middle cuneiform and second metatarsal, and externally with cuboid and fourth metatarsal.

Muscular attachments are for flexor brevis pollicis and tibialis posticus.

THE METATARSAL BONES have the same general form as the metacarpal bones of hand, each consisting of shaft, head, and base.

The *shaft* is prismoid and curved, with concavity below, convexity above.

The *head* is rounded for articulation with phalanges, and has *tubercles* laterally for ligaments and a *groove* below for tendon of long flexor.

The *base* is wedge-shaped for articulation with the tarsus and with each other.

The *first* and strongest articulates at base with internal cuneiform, at head with phalanx and second metatarsal, and has three muscular attachments—for tibialis anticus, peroneus longus, and first dorsal interosseous.

The *second* is wedged in by base between three cuneiform bones, articulates with second phalanx, first and third metatarsi, and has three muscular attachments—for adductor pollicis, first and second interosseous.

The *third* articulates with external cuneiform below and second and third metatarsi and third phalanx, and has four muscular attachments—for adductor pollicis, first plantar, and second and third dorsal interossei.

The *fourth* articulates at base with external cuneiform and cuboid and at extremity with third and fifth metatarsal and

fourth phalanx, and has four muscular attachments—for adductor pollicis, third and fourth dorsal, and second plantar interossei.

The *fifth* has marked tubercle on outer side. It articulates with cuboid, fourth metatarsal, and fifth phalanx, and has five muscular attachments—for flexor brevis minimi digiti, peroneus brevis and tertius, fourth dorsal, and third plantar interosseus.

THE PHALANGES have same general characteristics as in hand; but are compressed from side to side instead of from before backward. The muscular insertions to first row are—to great toe, transversus pedis, extensor brevis digitorum, adductor, abductor, and flexor brevis pollicis; to second, first and second dorsal interosseus; to third, third dorsal and first plantar interosseus; to fourth, fourth dorsal and second plantar interosseus; to fifth, abductor and flexor brevis minimi digiti and third plantar interosseus. To second row—to great toe, flexor and extensor longus pollicis; to remaining toes, extensor longus and brevis digitorum, flexor brevis digitorum, and lumbricales. To third row, or ungual phalanges—flexor longus and extensor longus and brevis digitorum.

The ossific centres are one each for the tarsus, excepting the os calcis, which has an epiphysis for posterior part, and two each for metatarsals and phalanges. These latter are arranged in phalanges, one each for shaft and base, and in metatarsals, one each for shaft and head, excepting great one, which has one each for shaft and base.

SESAMOID BONES are small, osseous masses, cartilaginous in early life, developed in the tendons to relieve pressure. They are of two kinds—those over articular surfaces of joints, as patella; and those applied to the surfaces of bones, as in tendon of peroneus longus in the groove of cuboid bone.

TABLE OF OSSIFICATION.

Name.	Centres.	Time of Appearance.
VERTEBRÆ.	3 Primary:—	
	1 for each lamina.	6th week.
	1 for each process.	
	1 for body.	8th week.
	4 Secondary Centres:—	
	1 for each transverse process.	16th year.
	2 for end of spinous process.	
	2 Additional Plates:—	
	1 epiphyseal plate on upper and under surface of body.	21st year.
		All unite by 30th year.
Atlas (3).	1 for each lateral mass.	8th week.
	1 epiphysis for anterior arch.	1st year.
Axis (6).	1 for lower part of body.	6th month.
	1 for each lamina.	
	2 for lateral processes.	6th fœtal month.
	1 for apex of odontoid process.	
Seventh Cervical.	1 for anterior and costal part of transverse process.	6th fœtal month; joins 5th or 6th year.
Lumbar Vertebræ (2).	1 for each tubercle of superior articular process.	
Sacrum (35).		
15.	3—1 for each body and upper and lower epiphyseal plate.	8th or 9th week. 16th year, and unites 18th or 20th year.
10.	2—1 for each arch.	6th or 8th month; joins 2d to 6th year.
6.	2 for each lateral mass of the first three vertebræ.	
4.	Each lateral surface has one epiphyseal articulation and adjoining edge.	18th to 25th year.
Coccyx (7).	1 for each piece.	
	1.	Birth.
	2.	5th to 10th year.
	3.	10th to 15th year.
	4.	15th to 20th year.
CRANIAL BONES.		
Occipital (7).	4 for tabular or epi-occipital.	8th fœtal week.
	1 for each condylar portion.	4th to 6th year; joined to sphenoid 18th to 25th year.
	1 for basilar portion.	
Parietal (1).	From membrane.	
	Single centre at parietal eminence.	7th to 8th fœtal week.

Name.	Centres.	Time of Appearance.
Frontal (2).	1 for each lateral portion.	7th to 8th week.
	From membrane.	United by 4th year.
Temporal (10).	1 for squamous process.	2d month.
	1 for auditory process.	Later.
	6 for petro-mastoid.	5th or 6th month.
	2 for styloid process.	
Sphenoid (14).	8 for post-sphenoid.	
	1 for each greater wing and external pterygoid plate.	
	1 for each internal pterygoid plate.	
	2 for posterior part of body.	1 for base appears before birth and one after birth.
	1 for each lingula.	
	6 for pre-sphenoid:— 1 for each lesser wing. 2 for anterior portion of body. 1 for each spheno-turbinal.	Appear from 8th week to third year, and union of all parts is accomplished by the 20th year, and with occipital, 18th to 25th year.
Ethmoid (3).	1 for each lateral mass.	4th to 5th fœtal month.
	1 for lamella.	Unite about 2d year.
FACE.		
Nasal.	1 for each bone.	6th week.
Superior Maxillæ (4).	1 pre-maxilla.	Very early.
	1 pre-palatine portion.	Antrum appears about fourth fœtal month.
	1 maxillary portion.	
	1 malar "	
Lachrymal.	A single centre.	7th week.
Malar.	Single centre.	6th week.
Palate.	Single centre at junction of plates.	2d fœtal month.
Inferior Turbinated.	Single centre.	Middle of fœtal life.
Vomer.	Single centre, but two laminæ.	8th week.
Inferior Maxilla.	Probably several centres; at birth consists of two halves.	Very early, being second in order.
BODY.		
Hyoid (5).	1 for body and for each cornua.	3 months after birth.

Name.	Centres.	Time of Appearance.
Sternum (6).	1 for manubrium. 4 for gladiolus. 1 for ensiform appendix.	Middle of fœtal life.
Ribs (3).	1 for each shaft, head, and tubercle, excepting the last two, which have but 2, the tubercles being absent.	Before vertebræ. Epiphysis for tubercle appears from 16th to 20th year, and unites about 25th.
Upper Extremity.		
Clavicle (2).	1 for shaft. 1 for sternal extremity.	About 30th day.
Scapula (7).	1 for body. 2 for coracoid process. 2 for acromion process. 1 for posterior border. 1 for inferior angle.	2d month. Completed between 20th and 25th year.
Humerus (7).	1 for shaft. 1 for head. 1 for tuberosities. 1 for radial head. 1 trochlear portion. 1 for each condyle.	8th week. Upper extremity ossifies 2d to 4th year. Complete about 20th year.
Ulna (3).	1 for shaft. 1 for olecranon. 1 for lower extremity.	8th week. 10th year. 4th year.
Radius (3).	1 for shaft. 1 for upper extremity. 1 for lower extremity.	Soon after humerus. 5th year; unites 17th to 18th year. 2d year; unites 20th year. Upper extremity joins 16th year; lower, 20th year.
Carpus.	Each has single centre:— Os magnum. Unciform. Cuneiform. Trapezium and semi-lunar. Scaphoid. Trapezoid. Pisiform.	 1st year. 1st year. 3d year. 5th year. 6th year. 8th year. 12th year.

Name.	Centres.	Time of Appearance.
Metacarpus (2).	Centres for each:—	
	1 for shaft and	8th or 9th week.
	1 for each distal extremity except thumb, which has one each for shaft and base.	3d year, and unites about 20th year.
Phalanges (2).	1 for each shaft and base.	8th week, and unites 18th to 20th year.
LOWER EXTREMITY.		
Os Innominata (8).	3 Primary:—	
	Ilium.	Same as vertebræ, 6th week.
	Ischium.	3d month.
	Pubes.	4th or 5th month.
	5 Secondary:—	
	1 crest of ilium.	Puberty.
	1 anterior inferior spinous process.	"
	1 tuber ischii.	"
	1 symphysis pubis.	"
	1 acetabulum.	13th or 14th year; completed 25th year.
Femur (5)	1 for shaft.	5th week.
	1 for upper extremity.	End of 1st year.
	1 for lower extremity.	9th fœtal month.
	1 for great trochanter.	4th year.
	1 for lesser trochanter.	13th or 14th year.
		Inferior extremity. The last is not united before the 20th year.
Patella.	Single centre.	3d to 6th year; completed about puberty.
Tibia (3).	1 for shaft.	7th week.
	1 upper extremity.	Birth; unites 20th year.
	1 lower extremity.	2d year; unites 18th year.
Fibula (3).	1 for shaft.	8th fœtal week.
	1 upper extremity.	4th year.
	1 lower extremity.	2d year; the lower unites first — about 20th year.

Name.	Centres.	Time of Appearance.
Tarsus.	4 os calcis:—	
	1 for body and	6th fœtal month.
	1 for posterior extremity.	
	1 each for the following:—	
	Cuboid.	9th month.
	Astragalus.	7th "
	Scaphoid.	4th year.
	Internal cuneiform.	3d "
	Middle "	4th "
	External "	1st "
Metatarsus.	1 for each shaft and digital extremity, except great toe, which is same as thumb.	7th week. 3d year.
Phalanges (2).	1 for each shaft and proximal extremity.	

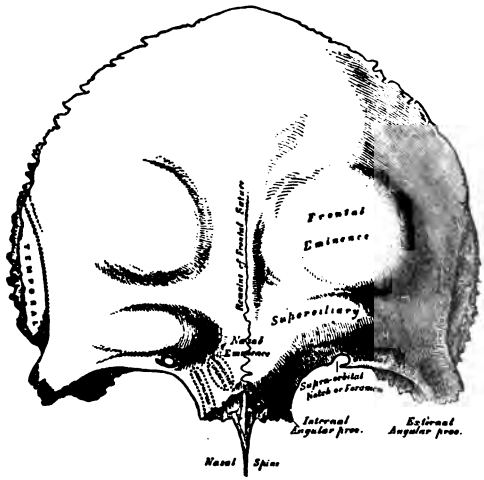


FIG. 30.

Frontal bone, outer surface.

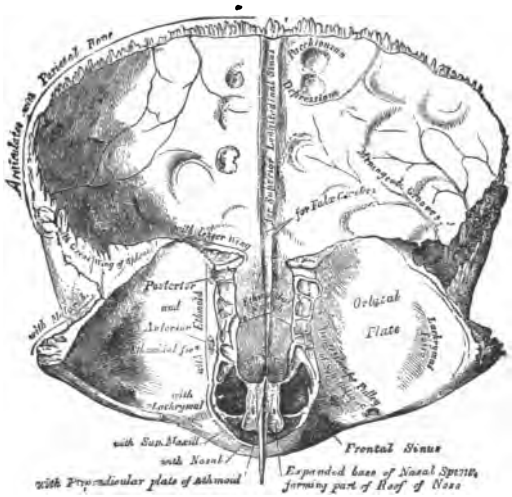


FIG. 31.

Frontal bone, inner surface.

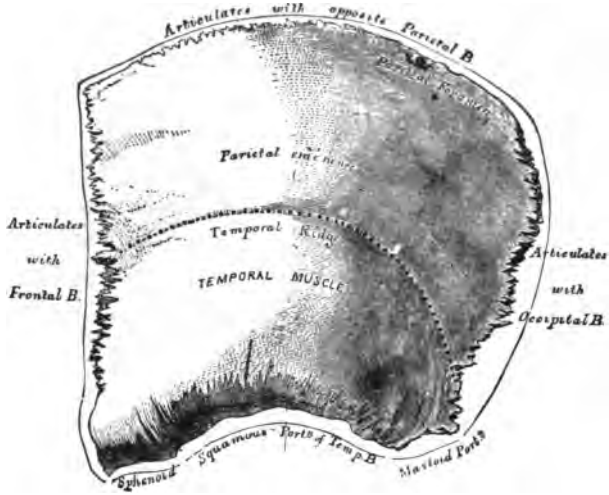


FIG. 32.

Parietal bone, outer surface.

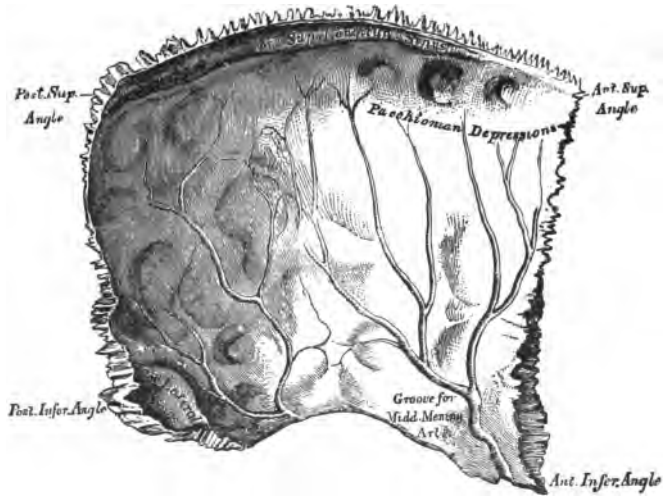


FIG. 33.

Parietal bone, inner surface.

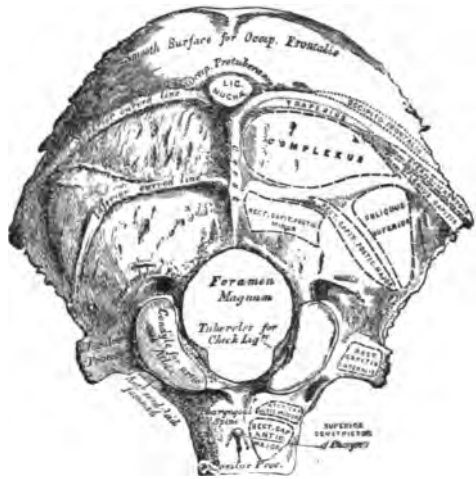


FIG. 34.

Occipital bone, outer surface.

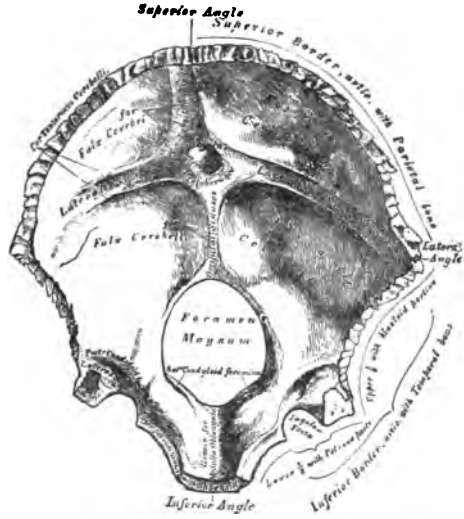


FIG. 35.

Occipital bone, inner surface.

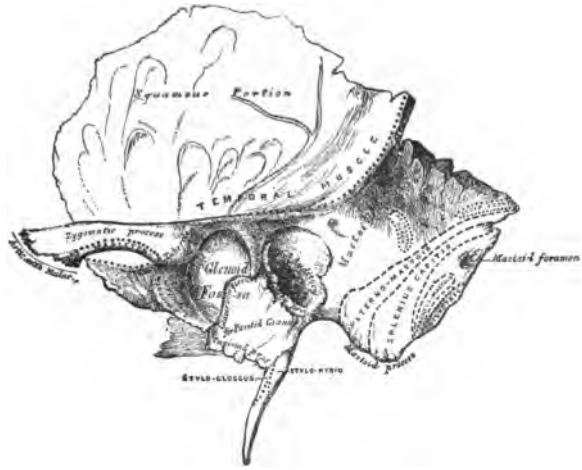


FIG. 36.

Left temporal bone, outer surface.

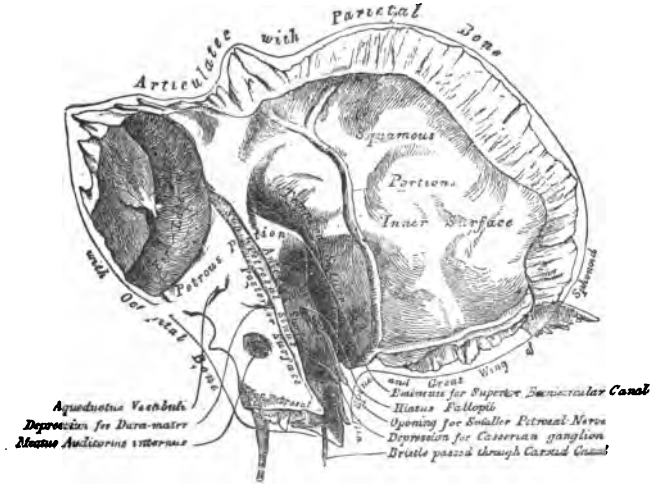


FIG. 37.

Left temporal bone, inner surface.

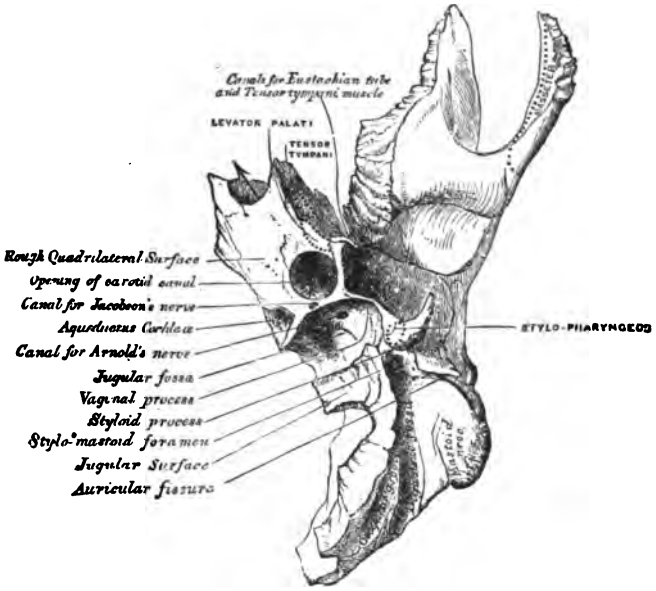


FIG. 38.

Left temporal bone, inferior surface of the petrous portion.

FIG. 39.

Section of the temporal bone (natural size) through the middle ear, Fallopian canal, mastoid antrum, and cells, showing dense bone between the antrum and cells, with no communication between them: 1, drumhead; 2, tip of the mallet handle; 3, anvil, showing the long crus at the right for articulation with the stirrup, and the short process at the left which serves the purpose of an anchor to the bone; 4, head of the mallet; 5, tensor-tympani muscle and tendon; 6, dense bone where pneumatic spaces are usually found; 7, pneumatic cells in the tip of the mastoid process; 8, Fallopian canal, for the facial nerve; 9, the stirrup. At the right of 9 and at the left of the anvil is the aditus ad antrum, connecting the tympanum with the antrum.

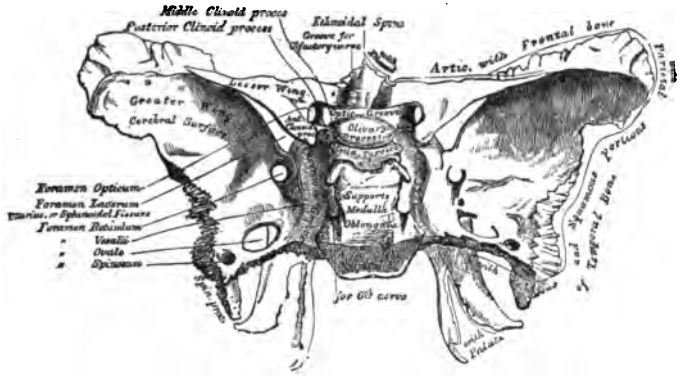


FIG. 40.

Sphenoid bone, upper surface.

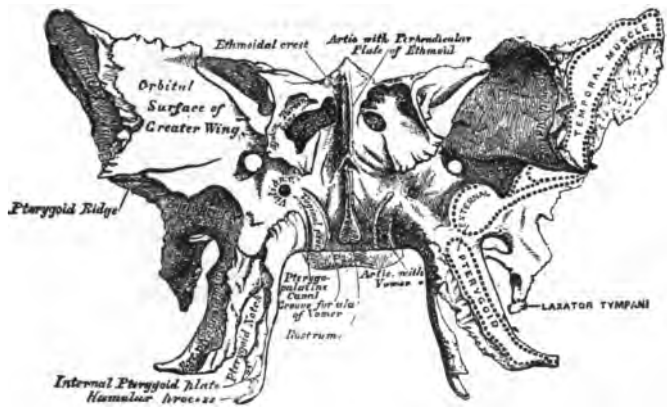
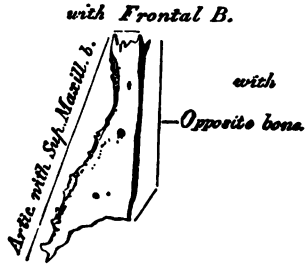


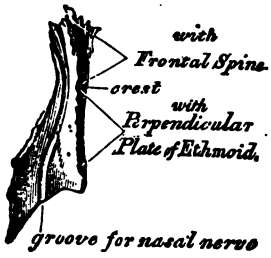
FIG. 41.

Sphenoid bone, anterior surface.

FIG. 42.
Ethmoid bone.



(Outer surface.)



(Inner surface.)

FIG. 43.
Nasal bones.

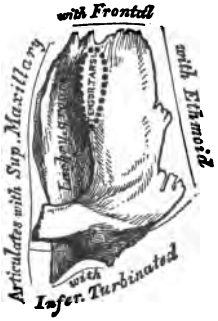


FIG. 44.
Lachrymal bone.

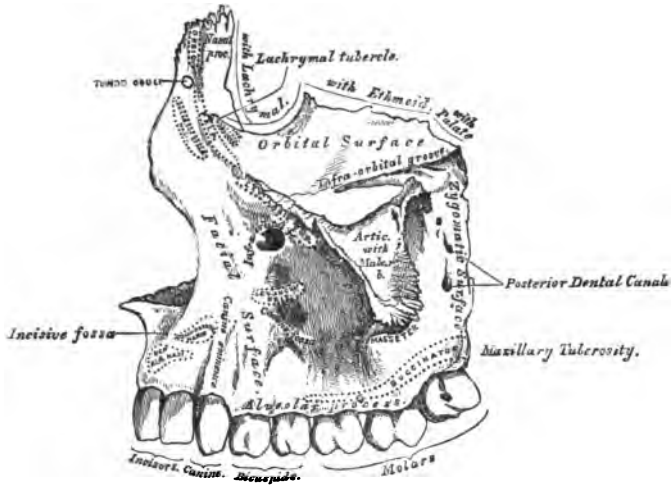


FIG. 45.

Superior maxillary bone.

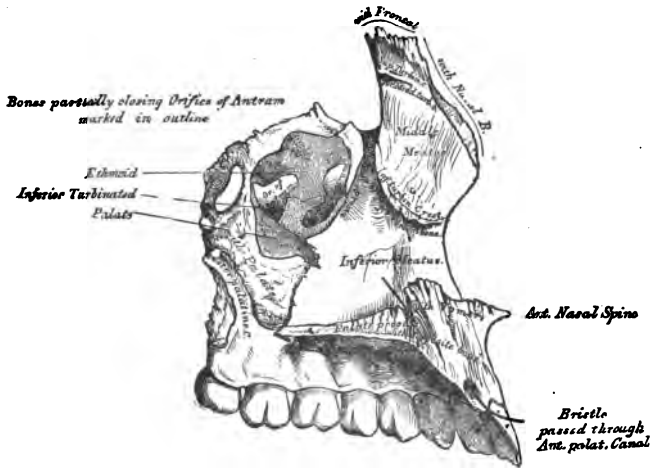


FIG. 46.

Superior maxillary, inner surface.

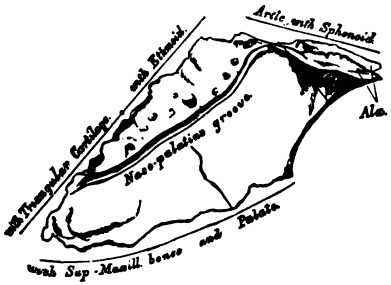


FIG. 47.
Vomer.

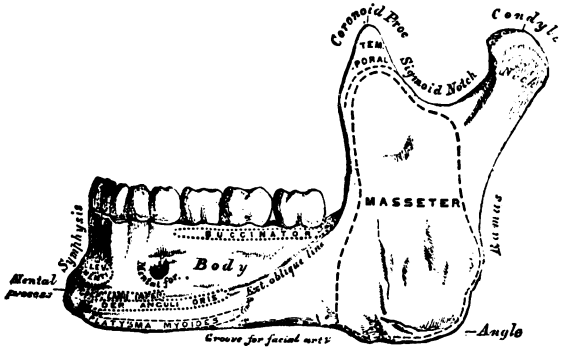


FIG. 48.
Inferior maxillary bone.

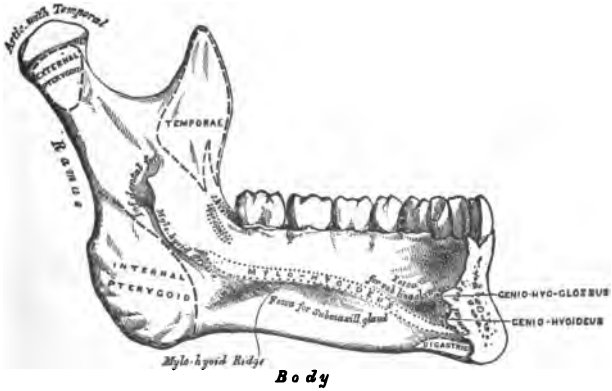
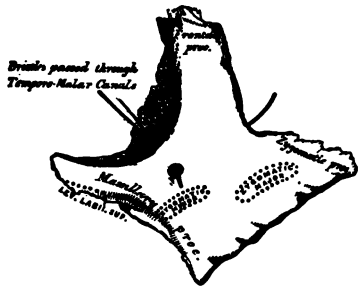


FIG. 49.
Left half of inferior maxillary bone, inner surface.



(Outer surface.) (Inner surface.)

FIG. 50.

Malar bones.

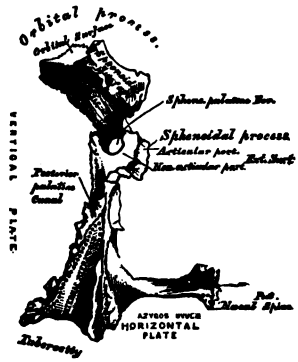


FIG. 51.

Palate bone (viewed posteriorly).

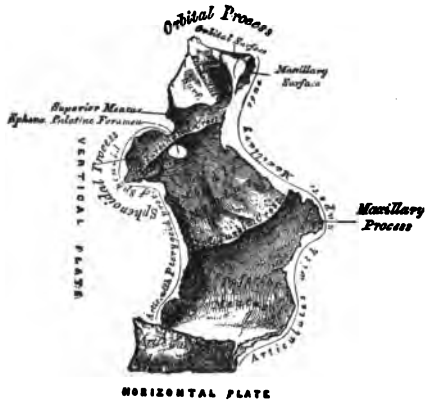


FIG. 52.

Palate bone (inner surface).

(Inner surface.)

(Outer surface.)

FIG. 53.

Inferior turbinated bones.

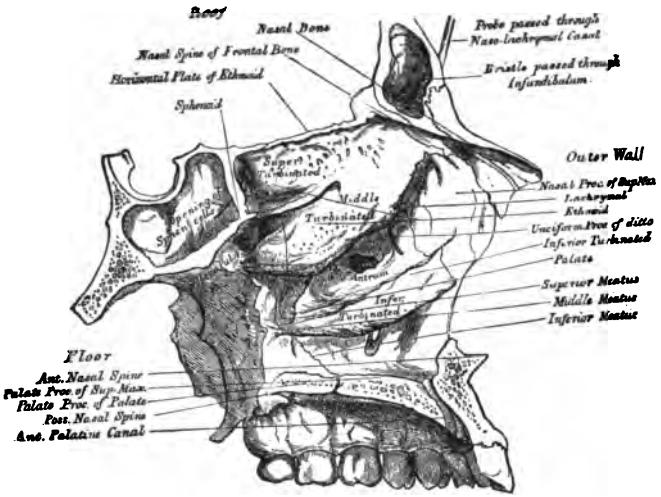


FIG. 54.

Nasal meatuses.

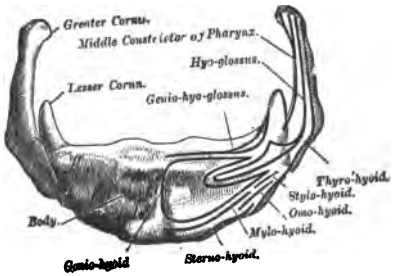


FIG. 55.

The hyoid bone.

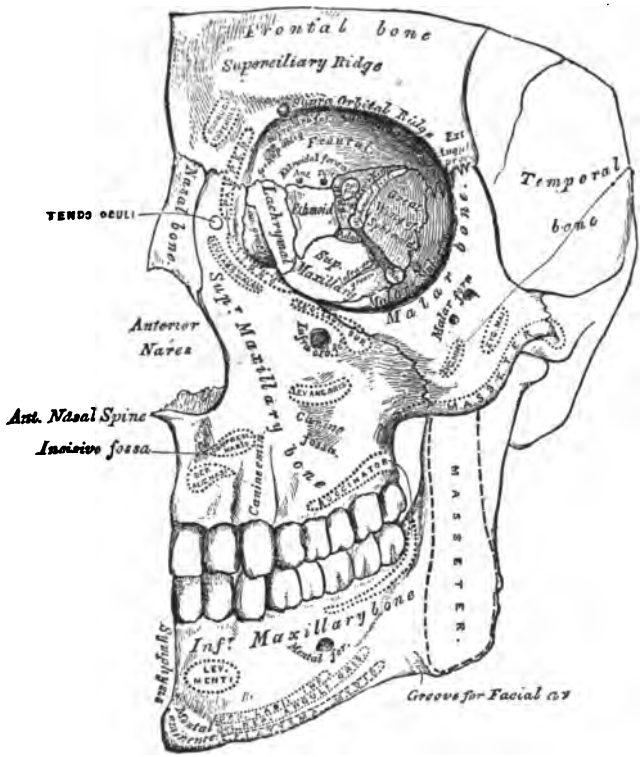


FIG. 56.

Facial portion of skull.

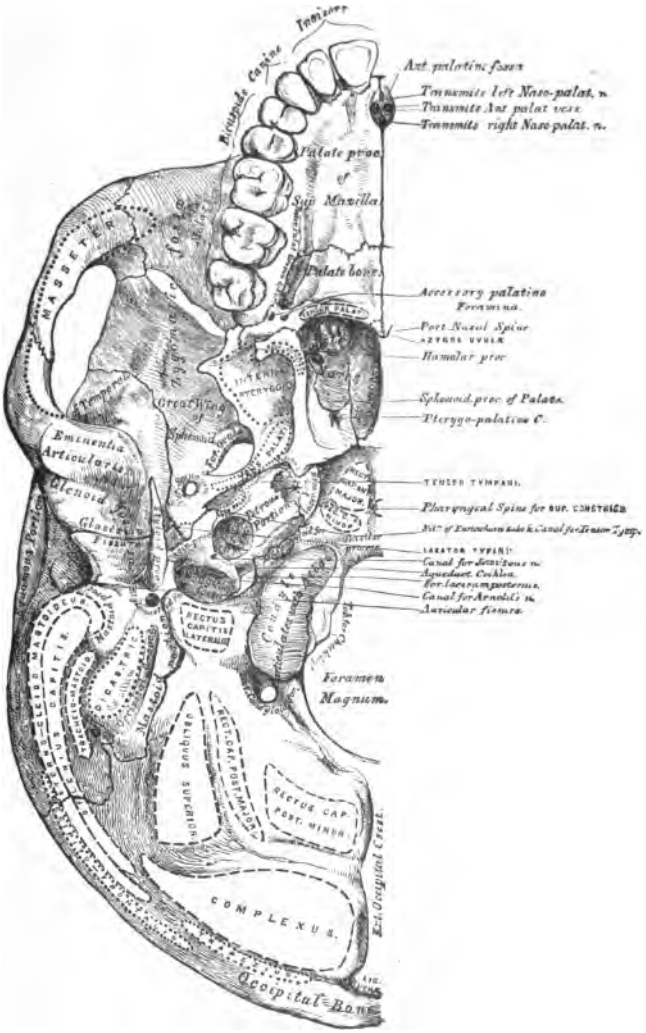


FIG. 57.

Base of skull, external surface.

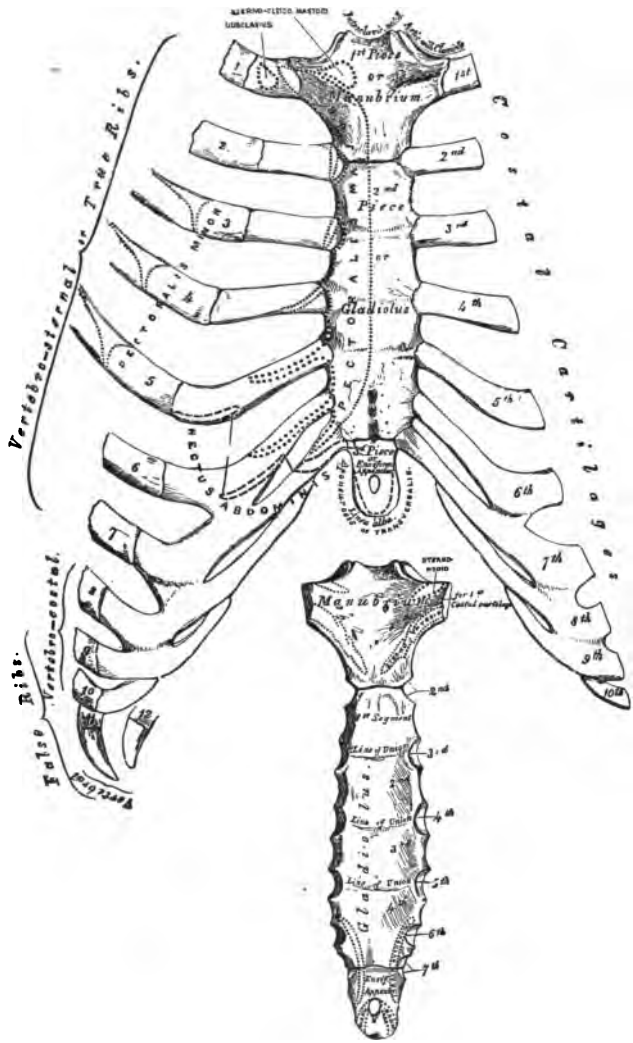


FIG. 58.

Sternum and costal cartilages.

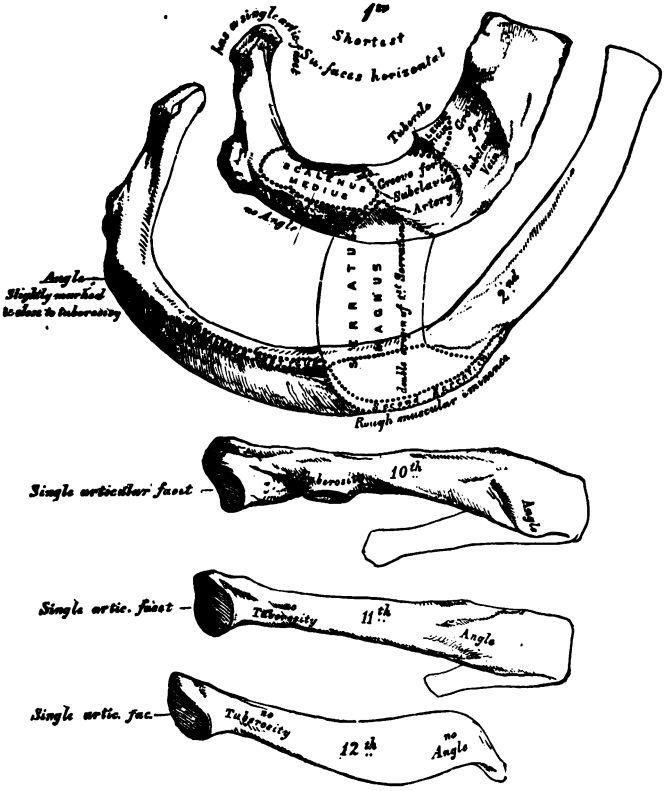


FIG. 59.

The peculiar ribs.

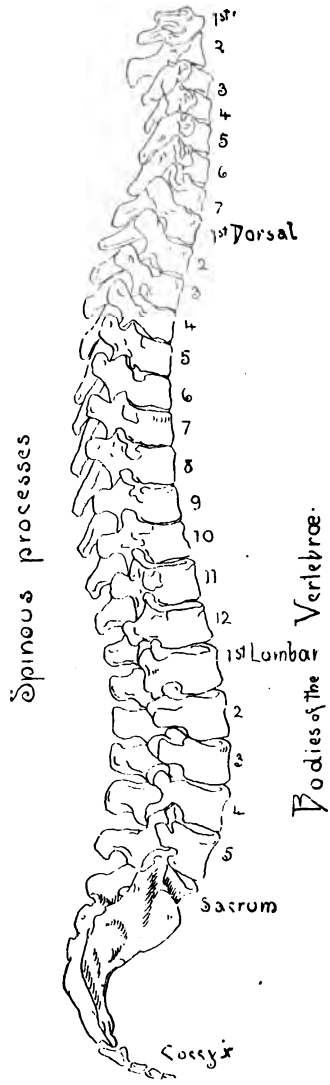


FIG. 60.

The vertebral column, or spine.

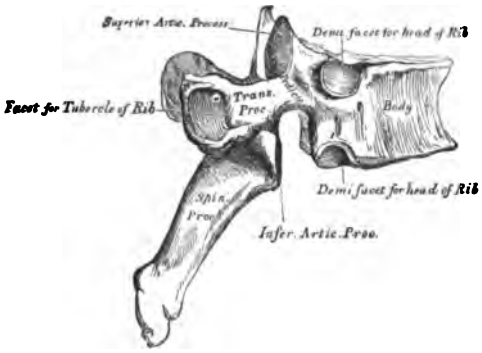


FIG. 61.

A dorsal vertebra.

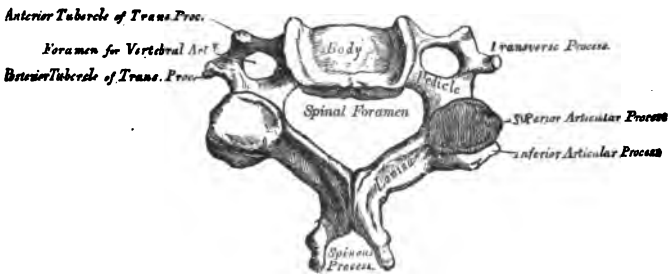


FIG. 62.

A cervical vertebra.

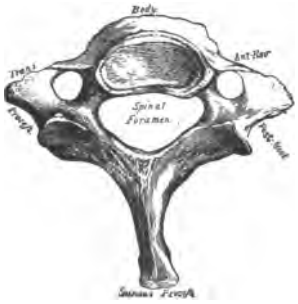


FIG. 63.

Seventh cervical, or vertebra prominens.

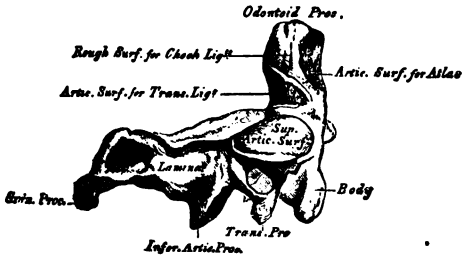


FIG. 64.

The axis.

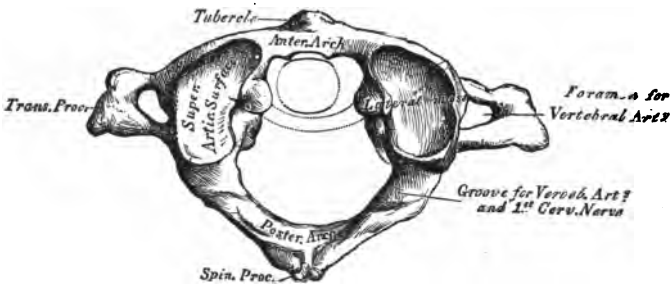


FIG. 65.

The atlas.

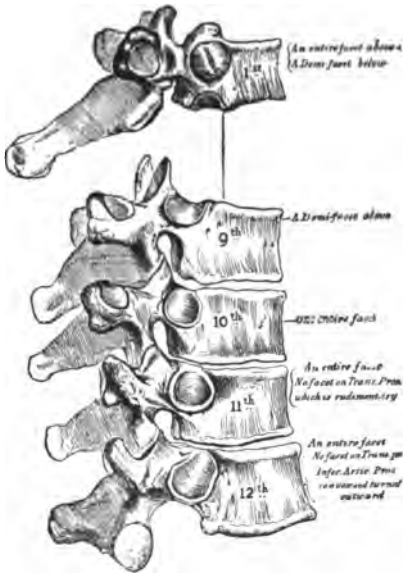


FIG. 66.

Peculiar dorsal vertebræ.

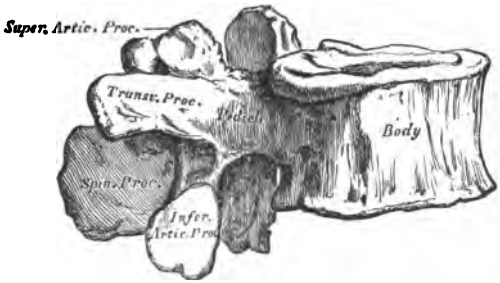


FIG. 67.

A lumbar vertebra.

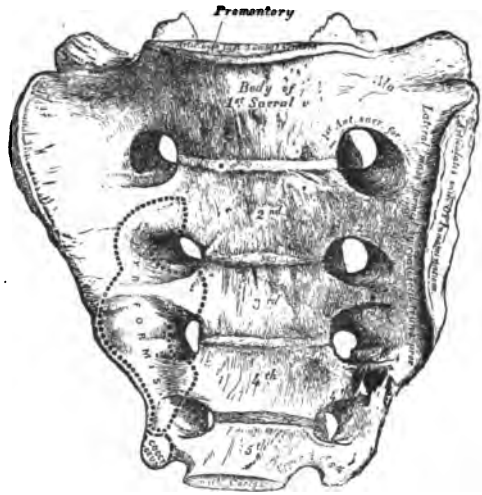


FIG. 68.

The sacrum, anterior surface.

FIG. 69.

The sacrum, posterior surface.

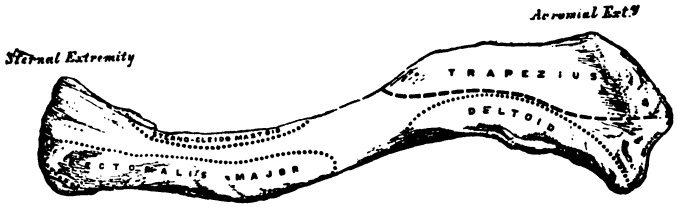


FIG. 70.

The left clavicle, upper surface.

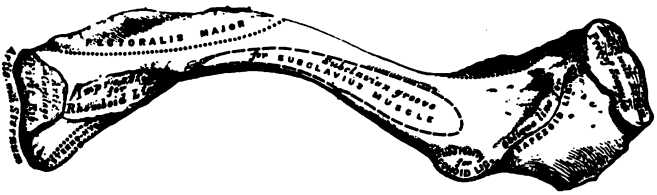


FIG. 71.

The left clavicle, under surface.

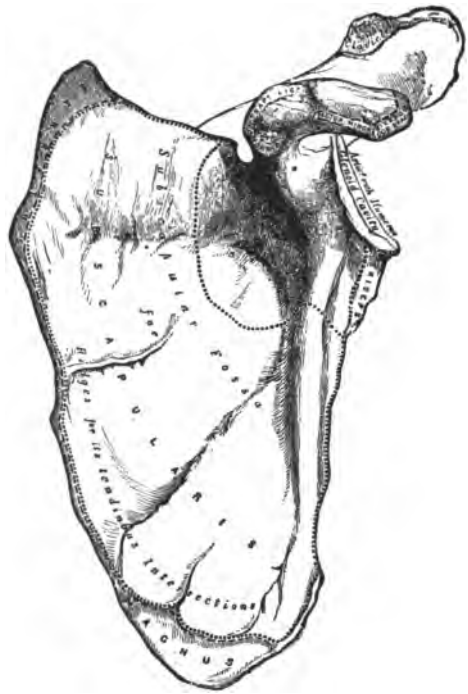


FIG. 72.

The scapula, anterior surface.

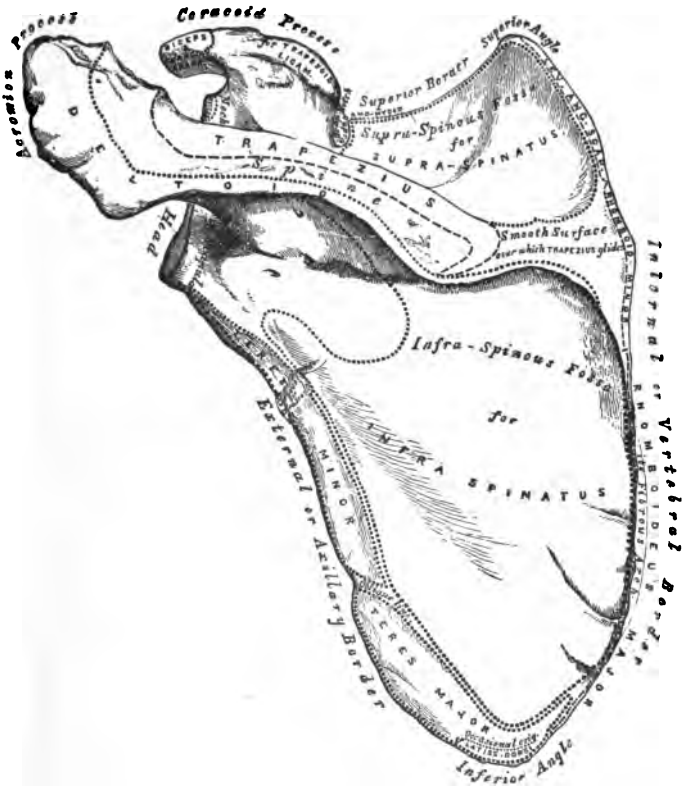


FIG. 73.

The scapula, posterior surface.

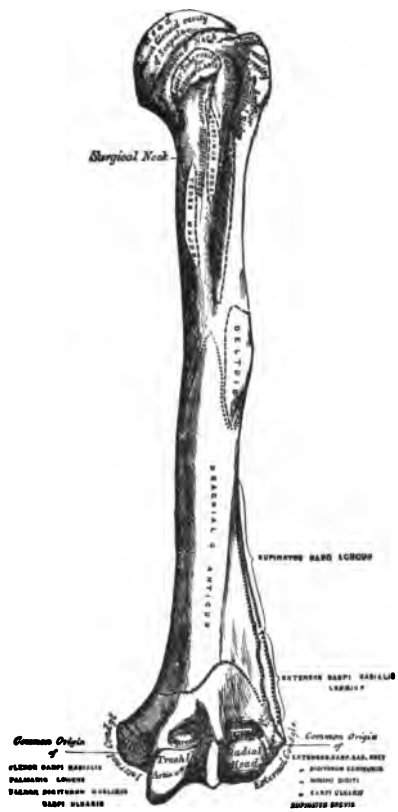


FIG. 74.

The humerus, anterior surface.

FIG. 75.

The humerus, posterior surface.

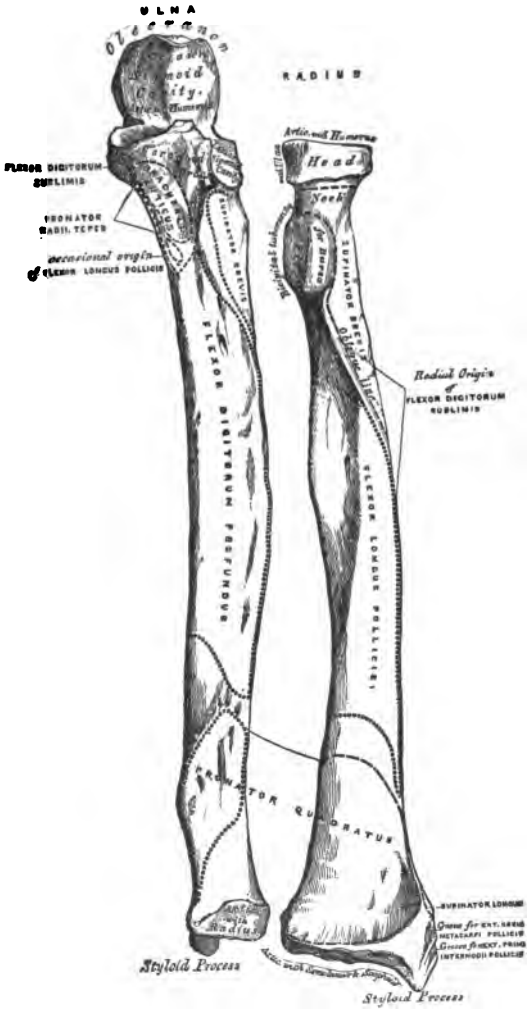


FIG. 76.

Ulna and radius, anterior aspect.

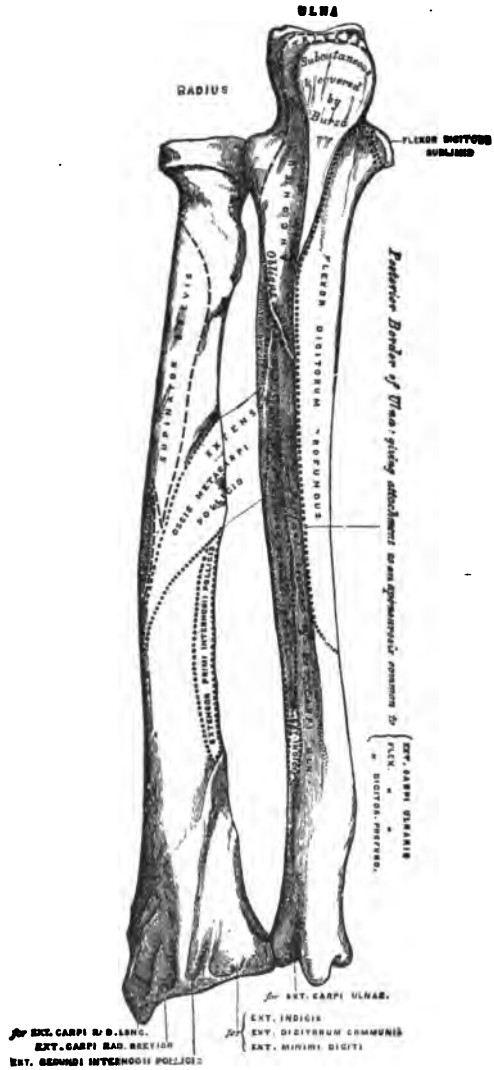


FIG. 77.

Radius and ulna, posterior aspect.

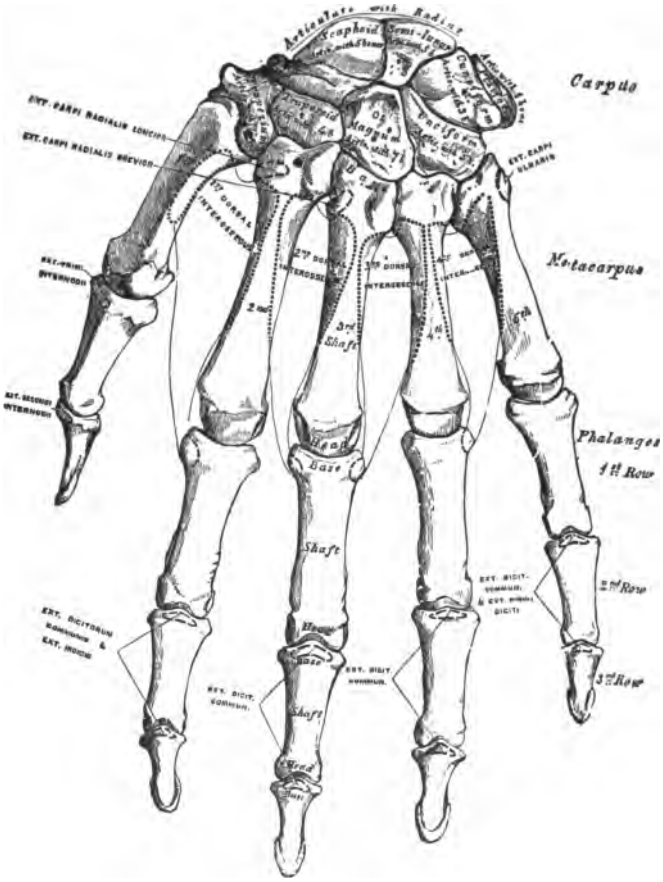


FIG. 78.

Carpus, metacarpus, and phalanges, dorsal surface.

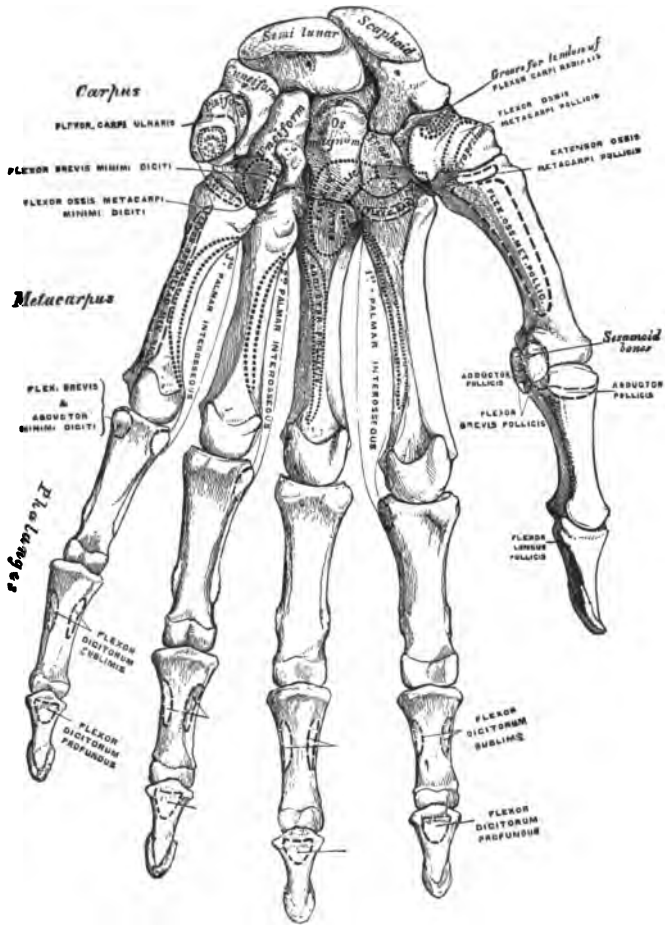


FIG. 79.

Carpus, metacarpus, and phalanges, palmar surface.

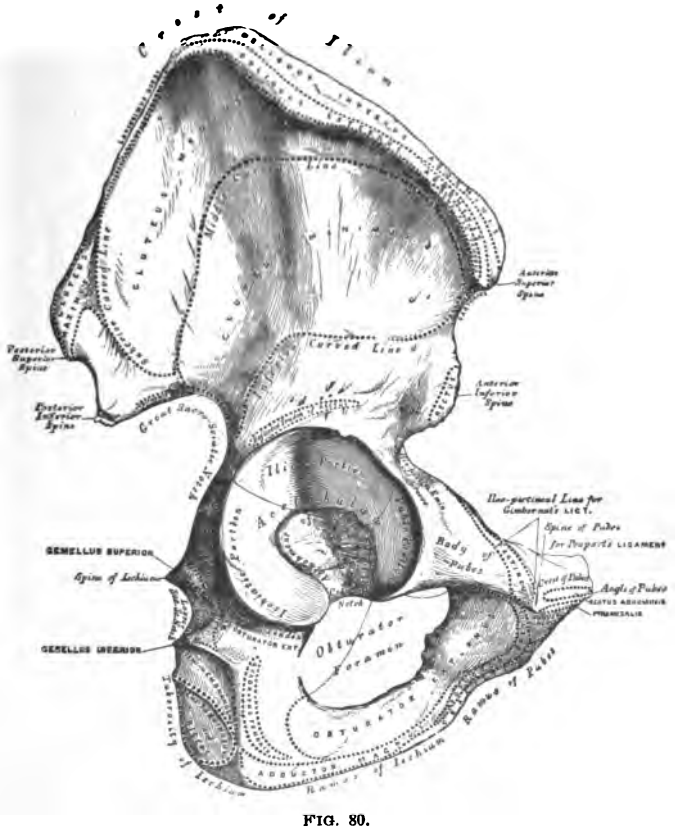


FIG. 80.

Os innominatum, outer surface.

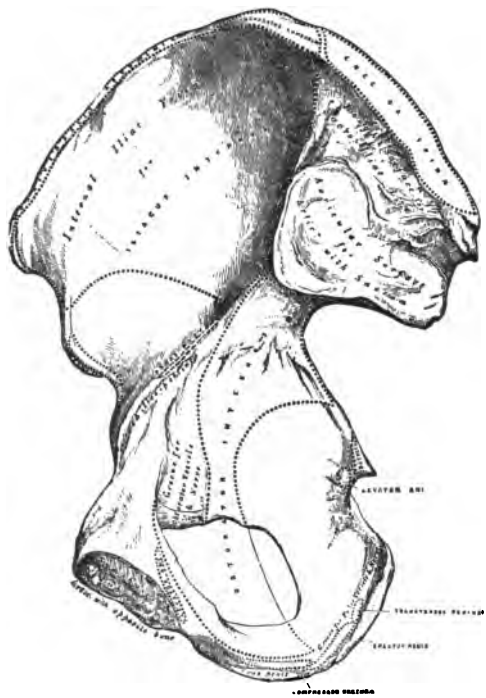


FIG. 81.

Os innominatum, inner surface.

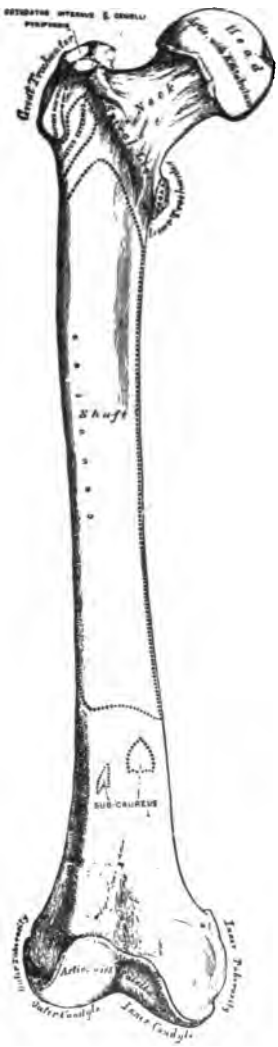


FIG. 82.

The femur, anterior surface.

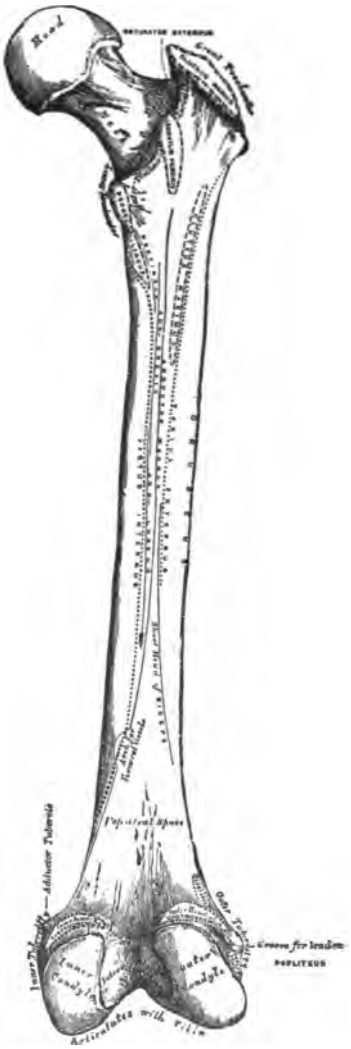


FIG. 83.

The femur, posterior surface.

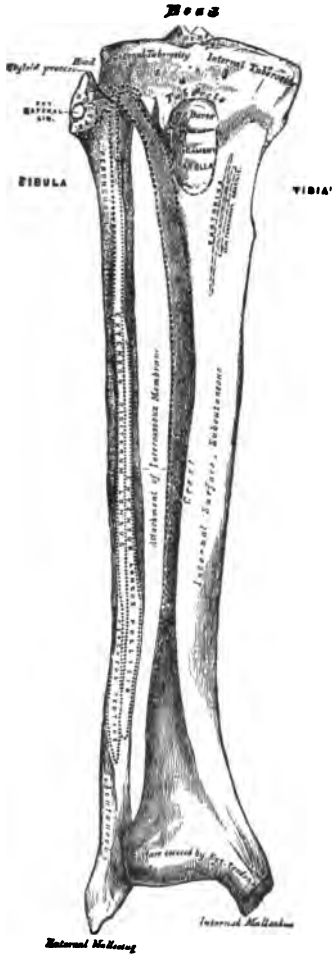


FIG. 84.

The tibia and fibula, anterior surface.

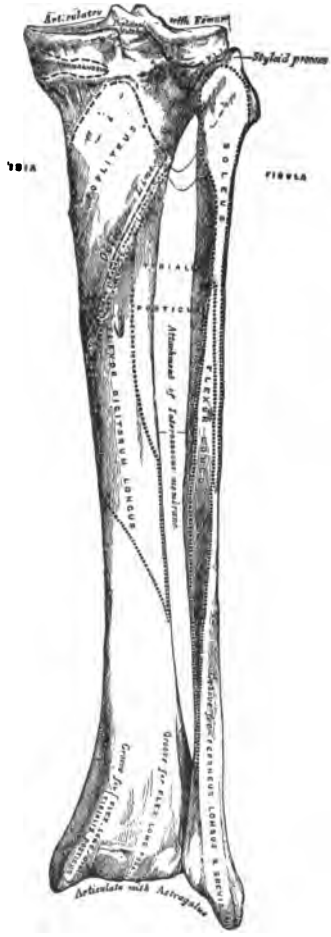


FIG. 85.

The tibia and fibula, posterior surface.

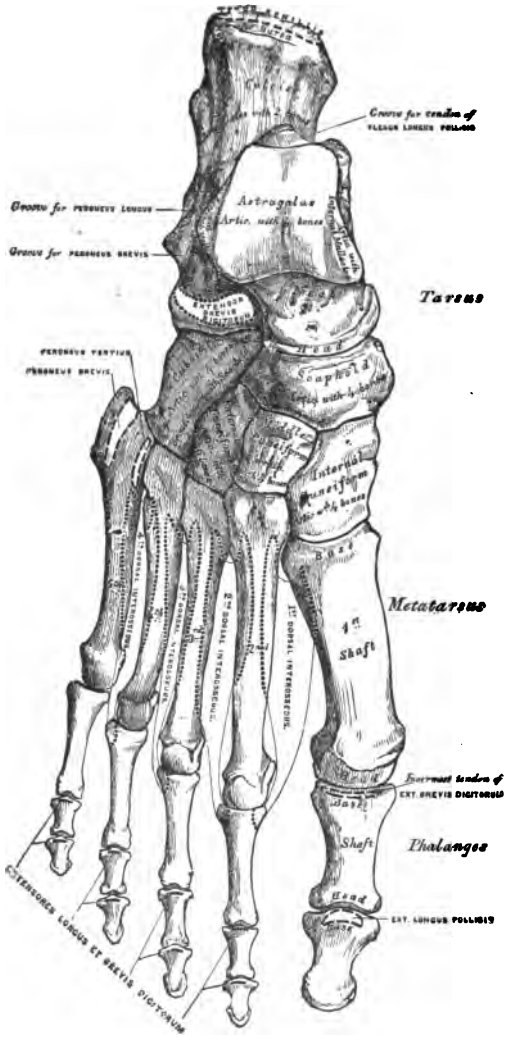


FIG. 86.

The tarsus, metatarsus, and phalanges, dorsal surface.

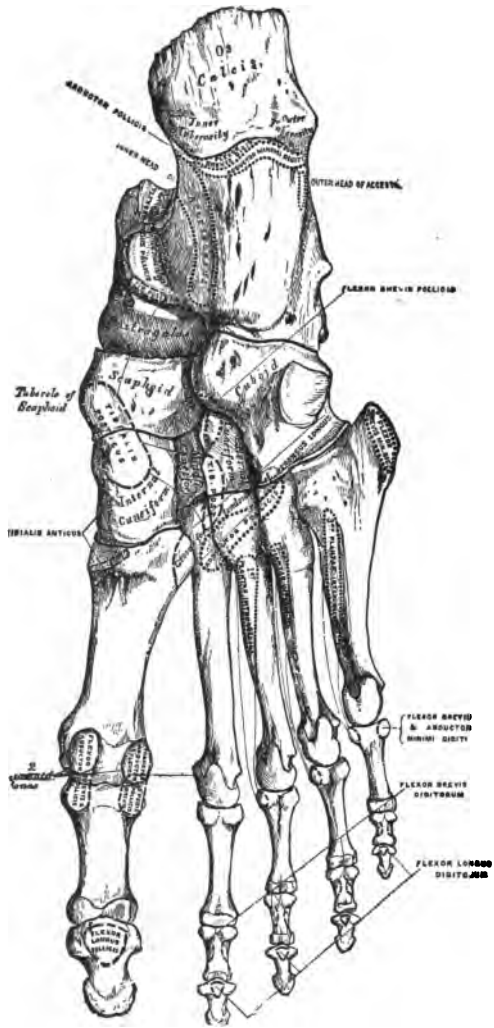


FIG. 87.

The tarsus, metatarsus, and phalanges, plantar surface.

ARTICULATIONS AND LIGAMENTS.

THE bones of the skeleton are connected together by articulations or joints.

These consist essentially of the expanded extremities of bones, covered with cartilage, often separated by interarticular fibro-cartilage, held together by ligaments, and lined by synovial membrane.

The *bone* entering into the articular lamella differs from ordinary bone by its extreme density, without Haversian canals, its lacunæ being much larger, and without canaliculi. It is not perforated by blood-vessels.

Cartilage is a whitish, highly elastic, non-vascular structure, forming in the fœtus the greater part of the skeleton, and found in the adult chiefly in the joints, the walls of the thorax, and certain orifices, as the nostrils, ears, etc.

It is either *temporary,* becoming ossified later, or *permanent,* remaining unossified. The latter is divided into three varieties: *articular,* in joints covering the ends of the bones; *costal,* forming part of the thorax; and *reticular,* arranged in plates or lamellæ to maintain the shape of parts.

Fibro-cartilage consists of a mixture of cartilaginous with white fibrous tissue. There are four varieties:—

(a) Interarticular, interposed between the joint surfaces;
(b) Connecting, binding bones together as in pubes;
(c) Circumferential, deepening cavities, as glenoid cavity of shoulder; and
(d) Stratiform, lining grooves for tendons.

Synovial membranes are of three kinds: *articular,* lining the cavities of movable joints throughout except the surface of the cartilage; *bursal,* irregular cavities interposed at convenient positions to alleviate friction; from their contents they may be either mucous or synovial; and *vaginal synovial membranes,* or sheaths, surrounding tendons and diminishing friction.

Synovia is a transparent, viscid liquid, albuminous in its nature.

The articulations consist of three (3) classes: diarthrosis, movable; synarthrosis, immovable; and amphiarthrosis, mixed.

1. The *diarthrosis* are subdivided into:—

Arthrodia, gliding-joint, as superior tibio-fibular;
Enarthrosis, ball-and-socket joint, as shoulder and hip;
Ginglymus, hinge-joint, as knee and ankle;
Trochoides, a ring surrounding a pivot, as atlo-axoid joint, and superior radio-ulnar.
Condyloid, elliptical cavity receiving an ovoid head, as wrist-joint.
Reciprocal reception, a concavo-convex articulation, as carpo-metacarpal joint of thumb.

2. *Synarthrosis,* surface, immovably connected by fibrous membrane without synovial membrane.

They are divided into:—

Sutura, bones interlocking with one another;
Schindylesis, a fissure in one bone receiving a plate of bones, as between vomer and sphenoid;
Gomphosis, a socket with a pivot inserted, as in alveolar cavities for teeth.
Synchondrosis, a temporary joint in which the connecting medium is cartilage.

The sutura may be either true, *sutura vera,* or false, *sutura notha,* the former having three divisions: dentata, tooth-like processes, as interparietal suture; serrata, saw-like edges, as interfrontal suture; limbosa, dentated processes and beveled margins, as fronto-parietal; the latter two divisions:—

Squamosa, overlapping beveled margins, and
Harmonia, by union of roughened surfaces, as intermaxillary suture.

3. *Amphiarthrosis,* bony surfaces connected by fibro-cartilage, with or without synovial membrane, as between vertebral bodies, and pubic symphysis.

MOTIONS IN JOINTS.—Joints admit of four (4) distinct varieties of motion:—

(a) Gliding movement, between contiguous surfaces;
(b) Angular movement, as flexion, extension, adduction, and abduction;
(c) Circumduction, as in true enarthrosis;
(d) Rotation on its own axis, as between the atlas and axis.

TEMPORO-MAXILLARY is formed by condyle of lower jaw, below articulating with glenoid cavity of the temporal bone and eminentia articularis above. It is a double arthrodial joint.

LIGAMENTS.—*External Lateral.—Origin,* tubercle on outer edge of zygoma; *insertion,* outer side of neck of condyle.

Internal Lateral.—Origin, spinous process of sphenoid; *insertion,* lower circumference of inferior dental foramen.

Capsular.—Origin, circumference of articulation; *insertion,* neck of condyle.

Interarticular fibro-cartilage is within cavity; external pterygoid muscle attached to its inner edge.

Synovial membrane is divided into two by cartilage.

Intermaxillary ligament passes from external pterygoid process to coronoid.

Stylo-maxillary Ligament.—Origin, styloid process; *insertion,* inner surface of angle of jaw. *Nerves* are derived from the auriculo-temporal and masseteric branches of the inferior maxillary.

ARTICULATIONS OF VERTEBRAL COLUMN.—These are formed between the contiguous surfaces of the vertebral bodies and articular processes, inclosed in capsular ligaments, and connected with the following ligaments:—

The *anterior common ligament* extends from the front of the body of the axis down the anterior surface of the spine to the sacrum, being expanded opposite, and attached to each intervertebral connecting fibro-cartilage;

The *posterior common ligament* descends along posterior surfaces of bodies from axis to sacrum within spinal canal. It also expands opposite and adheres to intervertebral substance;

Intervertebral substance, disks of varying size, twenty-seven in number, composed of decussating fibres of fibro-cartilage, arranged in crescentic laminæ with central, semi-pulpy substance, separate the vertebræ;

Ligamenta subflava descend in pairs, twenty-three on either side, from one lamina to another, from axis to sacrum, inclosing spinal canal;

Supra-spinous ligament, strong cord descending from one vertebra to another, from vertebra prominens (seventh cervical) to sacrum. Its continuation in cervical region forms *ligamentum nuchæ;*

Interspinous stretch between spinous processes throughout dorsal and lumbar regions;

Intertransverse, between transverse processes in lower dorsal and lumbar regions.

The *arteries* are derived from ascending cervical and vertebral in cervical, intercostals in dorsal, and lumbars in lumbar regions.

The *nerves* are from spinal nerves in each region.

ATLO-AXOID ARTICULATION consists of four joints, the two lateral joints being arthrodia, and that between the odontoid process and arch of atlas and transverse ligament—a diarthrosis

rotatoria—being double, one in front, *atlo-odontoid,* and one behind, *odonto-transverse.* The ligaments are:—

Anterior atlo-axoid, two—superficial and deep, connecting anterior borders together;

Posterior atlo-axoid, connecting the arches of the atlas and axis posteriorly, and pierced laterally by the second spinal nerve;

Capsular, two, connecting the articulating processes laterally, and lined with synovial membrane;

Transverse, or *cruciform,* arises from the tubercle on one side of the lateral mass, passes across the back of odontoid process to be inserted into the opposite tubercle.

The *arteries* are from vertebral, *nerves* from second cervical, or from loop between it and suboccipital.

OCCIPITO-ATLOID. — *Anterior occipito-atloid* — two, superficial and deep, connecting the tubercle and upper border of anterior arch of atlas with basilar process and margin of foramen magnum of occiput.

Posterior occipito-atloid (membranous), connects the upper border of posterior arch of atlas with posterior margin of foramen magnum.

Lateral ligaments, two bands connecting transverse process of atlas with jugular process of occipital.

Capsular ligaments connect the articular processes of atlas with condyles of occiput.

The *arteries* are from vertebral; *nerves,* from suboccipital.

OCCIPITO-AXOID.—*Occipito-axoid* is a broad band, the continuation of posterior common ligament, extending from the body of the axis to basilar groove of occipital.

Odontoid, or *check,* pass upward and outward from the summit of the odontoid process, to be inserted into the inner side of the occipital condyles.

Ligamentum suspensorium, or *central occipito-odontoid,* arises from the centre of the transverse ligament at the apex of the odontoid process, and passes upward, to be inserted into the anterior margin of the foramen magnum.

Occipito-cervical, or *cervico-basilaris,* arises from the bodies of the third cervical and axis, and is inserted into the basilar groove of occipital.

The *arteries* are from vertebral; the *nerves* from suboccipital.

Capsular ligaments.—Throughout the spine the articulations between the facets of the articular processes are surrounded by capsular ligaments, making twenty-five pairs in all.

COSTO-VERTEBRAL ARTICULATIONS. — The *costo-vertebral* have each a double arthrodia between the head of the rib and the

bodies of the two adjacent vertebræ, except the first, tenth, eleventh, and twelfth ribs, which have each but a single joint.

Anterior Costo-vertebral, or Stellate Ligament.—Origin, head of the rib; *insertion,* into body of vertebra above and below, and interarticular cartilage between.

Interarticular costo-vertebral is within the capsular ligament, from the crest on the head of the rib to the intervertebral substance.

Capsular ligament surrounds the articular surfaces.

Costo-transverse articulations are united by three ligaments —anterior, middle, and posterior costo-transverse ligaments— extending between the tubercles of the ribs to the transverse process below. *Arteries,* the intercostals; *nerves,* anterior branches of spinal.

COSTO-STERNAL ARTICULATIONS.—These are connected by arthrodia excepting the first, which is a synarthrodia.

Anterior chondro-sternal ligaments connect the chondral and sternal surface in front;

Posterior chondro-sternal connect them behind.

Capsular ligaments surround all, and *synovial membranes* are present in all but the first, while the second has an interarticular cartilage interposed.

The *chondro-xiphoid* ligament connects the cartilage of the seventh, and sometimes the sixth rib with the xiphoid appendix.

Interchondral and Costo-chondral Articulations.—The ribs are connected with their cartilages by the periosteum covering them. The cartilages of the sixth, seventh, and eighth ribs, and sometimes the fifth and ninth, are connected by *anterior* and *posterior inter-chondral* ligaments, held together by capsular ligaments and lined with synovial membrane.

LIGAMENTS OF STERNUM.—The first and second portions of the sternum are articulated by an amphiarthrodial joint, sometimes a diarthrodial joint, connected by the *anterior intersternal* and *posterior intersternal ligaments,* and lined with synovial membrane.

The third portion, or ensiform cartilage, is united to the gladiolus by a synarthrodial joint.

THE THORAX.

The thorax is a conical osteo-cartilaginous framework, formed by the dorsal vertebræ behind, the ribs, intercostal muscles, and costal cartilages laterally, and the sternum in front.

The *apex,* or *superior opening,* is bounded behind by the first dorsal vertebra, laterally by the first rib, and in front by the upper border of the sternum.

It transmits the following structures:—

Œsophagus, trachea, thoracic duct (on left side), lymphatic vessels of right side of chest and of surface of liver, innominate artery (right side), left common carotid artery, left subclavian artery, right and left superior intercostal arteries, right and left internal mammary arteries, thyroidea ima artery (if present), right and left inferior thyroid veins, right and left innominate veins, right and left phrenic nerves, right and left pneumogastric nerves and their cardiac branches, left recurrent laryngeal nerve, right and left first dorsal nerves, right and left sympathetic nerves and their cardiac branches, apices of lungs and pleuræ, remains of thymus, and deep cervical fascia passing to pericardium.

The longus colli, sterno-hyoides, and sterno-thyroides on both sides also pass through it.

The *inferior opening* is formed by the last dorsal vertebra behind, the last rib laterally, and the ensiform cartilage in front. It is filled in by the diaphragm.

The *cavity* of the thorax contains the following structures: the heart and great vessels, trachea, bronchi, and lungs, azygos and bronchial veins, internal mammary arteries, pneumogastric, phrenic, and splanchnic nerves, thoracic duct, œsophagus, lymphatic vessels, and glands (*vide* mediastinum).

SPINE AND PELVIS.—*Sacro-vertebral articulation.* In addition to those of the spine, given above, there are two ligaments connecting the last lumbar vertebra with the sacrum:—

Lumbo-sacral ligament, arising from the transverse process of the last lumbar vertebra, and inserted into the base of the sacrum;

Ilio-lumbar ligament, arising from the apex of the transverse process of the last lumbar vertebra, and inserted into the crest of the ilium. The *arteries* are from last lumbar, ilio-lumbar, and lateral sacral. The *nerves* are branches of fourth and fifth lumbar and sympathetic.

Sacro-iliac articulation, between the articular surfaces of the sacrum and ilium, is an amphiarthrodial joint connected by

The *anterior sacro-iliac* ligament, crossing between anterior surfaces of the two bones;

Posterior sacro-iliac ligament, the stronger, passes in different directions between the posterior surfaces of the two bones, firmly binding them together. One of these, stronger than the others, passes from the posterior superior spinous process to the third sacral transverse process. It is called

The *oblique sacro-iliac* ligament.

The *arteries* are from gluteal, sacral, spinal, and ilio-lumbar; the *nerves* from lumbo-sacral and posterior sacral cords.

Sacro-ischiatic Articulation.—The os innominatum and sacrum are united by two important ligaments—the *great sacro-sciatic* (posterior) ligament, and the *lesser sacro-sciatic* (or anterior) ligament.

The *great sacro-sciatic* ligament arises from the fourth and fifth transverse tubercles of the sacrum, from spine of ilium, sacrum, and coccyx, and passes downward, outward, and forward, to be inserted into the inner margin of the tuberosity of the ischium, being prolonged forward as the *falciform ligament* protecting the internal pudic veins and nerves.

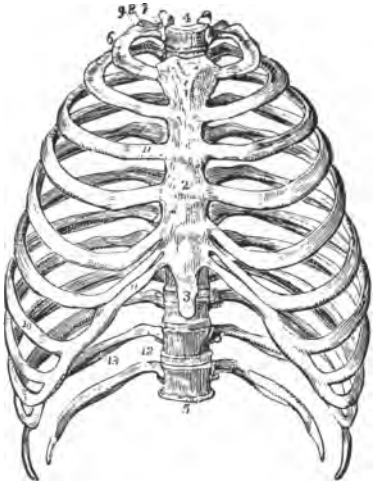


FIG. 88.

1, manubrium; 2, gladiolus; 3, xiphoid appendix; 4, first dorsal vertebra; 5, last dorsal vertebra; 6, first rib.

It converts the sacro-sciatic notch into the lesser sacro-sciatic foramen, transmitting the obturator internus muscle and nerve, the internal pudic vessels and nerves.

The *lesser sacro-sciatic* ligament arises from the lateral margin of the sacrum and coccyx, and is inserted into the spine of the ischium. It converts the sacro-sciatic notch into the *greater sacro-sciatic foramen,* transmitting the pyriformis muscle, gluteal vessels, superior gluteal nerve, sciatic vessels and nerves, and the internal pudic vessels and nerves.

Sacro-coccygeal articulation is an amphiarthrodial joint, resembling the vertebral, having an interarticular fibro-cartilage, and connected together by

An *anterior sacro-coccygeal* ligament, and

A *posterior sacro-coccygeal* ligament, continuations respectively of the anterior and posterior common ligaments.

Lateral sacro-coccygeal, *intertransverse,* and *intercornual* ligaments connecting the rudimentary transverse processes and the cornua together.

The *arteries* are from lateral and median sacral;

The *nerve* branches of coccygeal, fifth sacral, and posterior divisions of fourth sacral.

PUBIC ARTICULATION.—This is an amphiarthrodial joint, known also as the *symphysis pubis.*

It is connected by the

Anterior pubic ligament in front;

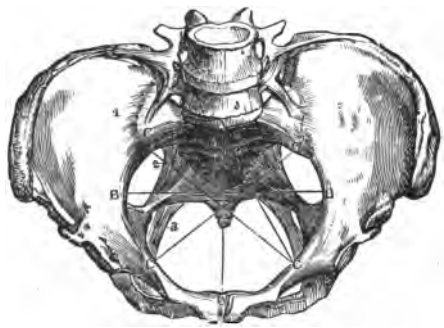


FIG. 89.

A A, antero-posterior diameter; B B, transverse diameter; C C, oblique diameter; 1, sacro-iliac ligament; 2, anterior or lesser sacro-sciatic ligament; 3, posterior or great sacro-sciatic ligament.

Superior pubic ligament above;

Posterior pubic ligament behind;

Subpubic ligament below, forming the boundary of the pubic arch.

Within the joint an *interposed fibro-cartilage* separates the bones.

The *obturator membrane,* or ligament, closes the obturator foramen, and affords attachment for the external and internal obturator muscles and allows passage at its upper outer part, for the obturator vessels and nerves.

THE PELVIS.

The pelvis is a strong, bony basin, formed at the lower end of the vertebral column by the articulation of the sacrum and coccyx posteriorly with the ossa innominata laterally.

It is divided into a false and true pelvis by the ilio-pectineal line.

The *false pelvis* is situated above the ilio-pectineal line, and corresponds to the expanded iliac fossæ, being bounded laterally by the ossa ilii, and having in front and behind wide intervals.

The *true pelvis* includes all that portion below the linea ilio-pectinea, and presents a cavity, superior circumference or inlet, and an inferior circumference or outlet.

The *inlet* is heart-shaped, being bounded behind by the promontory of the sacrum, laterally by the linea ilio-pectinea, and in front by the crest and spine of the pubes.

Its principal diameters in the female are:—

Antero-posterior, from symphysis to vertebral angle, four and three-fourths inches; transverse, across the widest part, five and one-fourth inches; and oblique, from the ilio-pectineal eminence in front to the sacro-iliac symphysis behind, five inches. In the male, these measurements are about three-fourths of an inch less in every diameter.

It transmits the following structures:—

Viscera and Ducts.

1. Small intestine.
2. Rectum.
3. Vasa deferentia (in male), round ligaments (in female).
4. Ureters.
5. Urachus and obliterated hypogastric arteries.
6. Uterus (pregnant).
7. Bladder (distended).
8. Peritoneal coverings.

Vessels.

1. Superior hæmorrhoidal.
2. Internal iliac.
3. Sacra media.
4. Ilio-lumbar.
5. Branches of vasa intestini tenuis.
6. Obturator (from deep epigastric).
7. Ovarian.
8. Pubic branches from external epigastric arteries.
9. Lymphatic vessels.

Nerves.

1. Sympathetic.
2. Branches from hypogastric plexus.
3. Obturator.
4. Lumbo-sacral cord.

The *cavity* of the *pelvis* is bounded behind by the sacrum and coccyx, in front by the symphysis, and laterally by the body of the ischium, forming a curved canal, widest in the middle. It contains, in the recent state, the organs of generation, rectum, bladder, and their vessels, nerves, ducts, etc. Its axis corresponds to the concavity of the sacrum and coccyx.

Its depth in front, at the symphysis, is about one and a half in the middle axial line, three and a half behind, in males four and a half to possibly five and a half.

The *outlet* of the *pelvis* is bounded by three prominences, the tuber ischii laterally and the coccyx behind; separated by three notches, the subpubic arch in front and the sacro-sciatic notches posteriorly.

Its principal diameters are: transverse, three and a half in male, four and three-fourths in female; antero-posterior and oblique, three and one-fourth in male, five in female.

In the erect position the pelvis is placed at an angle of from sixty degrees to sixty-five degrees with the ground.

DIFFERENCES OF SEX.—The *male pelvis is* characterized by the strength of the bones, by prominent muscular impressions, by the depth and narrowness of the cavity, the large obturator foramen, and the acute angle of the subpubic arch.

The *female pelvis* is characterized by the lightness of the bones, the slight muscular impressions, by the shallow expanded iliac fossæ, the increased size of the cavity in every diameter, and the obtuse angle of the subpubic arch.

ARTICULATIONS OF THE UPPER EXTREMITY.

The *sterno-clavicular articulation* is an arthrodial joint, formed between the sternal end of the clavicle and the sternum and first rib, being divided into two cavities by an interarticular fibro-cartilage. Its ligaments are:—

Anterior sterno-clavicular, is a broad band passing between the articular margins, attached to the interarticular cartilage and two synovial membranes, and forming the front part of the capsular ligament;

Posterior sterno-clavicular, passes over the posterior aspect of the joint and corresponds to the former;

Interclavicular, passes from the sternal end of the clavicle on one side across the supra-sternal notch to the clavicle of the opposite side;

Costo-clavicular, or *rhomboid,* passes from the rhomboid impression on the inferior surface of the clavicle to the upper surface of the first costal cartilage.

The *synovial membranes* form two sacs separated by the interarticular cartilage.

The *arteries* are from muscular branch of supra-scapular and contiguous muscular branches;

The *nerves,* from descendens noni.

ACROMIO-CLAVICULAR ARTICULATION is an arthroidal joint formed between the acromial extremity of the clavicle and the acromial process of the scapula. Its ligaments are:—

The *superior acromio-clavicular,* connect the adjoining parts of the superior surfaces of the clavicle and acromion process;

Inferior acromio-clavicular, connecting the inferior surfaces;

Coraco-clavicular, consists of two parts:—

Trapezoid, broad, square, arises from upper surface of coracoid process, and is inserted into oblique line on under surface of clavicle; and

Conoid, behind and internal, arises from base of coracoid process, and is inserted into conoid tubercle on under side of clavicle and a line internal to it.

FIG. 90.

1, superior acromio-clavicular ligaments; 2, coraco-clavicular ligaments; 3, coraco-acromial ligaments; 4, transverse ligament; 5, capsular ligament; 6, coraco-humeral ligament; 7, tendon of biceps.

The *capsular* ligament covers the anterior and posterior surfaces of the joint, uniting above and below with the superior and inferior acromio-clavicular ligaments.

The *arteries* are from anterior circumflex, acromial thoracic, and supra-scapular.

The *nerves* are anterior circumflex and supra-scapular.

The scapula has, also,

The *coraco-acromial,* arising from the outer border of the coracoid process and inserted into the summit of the acromion, and

Transverse, a ligamentous band bridging the supra-scapular notch, converting it into a foramen for supra-scapular nerve.

THE SHOULDER-JOINT is an enarthrodial joint, formed above by the glenoid cavity of the scapula and below by the head of the humerus. Its ligaments are—glenoid, coraco-humeral, and capsular.

The *glenoid* surrounds the edge, deepens the glenoid cavity, and is continuous above with the long head of the biceps tendon.

The *capsular ligament,* extensive and loose, arises above it from circumference of glenoid cavity behind the ligament, is attached below to the anatomical neck of humerus, and is pierced by tendons of two or three muscles.

The *coraco-humeral,* or *accessory,* is a fibrous band which extends obliquely downward and outward from the coracoid process to the anterior part of great tuberosity, strengthening the capsular ligament.

The synovial membrane is extensive and reflected upon the tendons of biceps, infra-spinatus, and sub-scapularis muscles.

Its *arteries* are derived from the subscapular, supra-scapular, dorsalis scapulæ, anterior and posterior circumflex;

Its *nerves,* from the subscapular, supra-scapular, and circumflex.

THE ELBOW-JOINT is a ginglymoid articulation formed above by the lower extremity of humerus, below by upper extremities of ulna and radius. Its ligaments are external and internal lateral, anterior and posterior ligaments.

External lateral arises from external condyle of humerus and is inserted into outer margin of ulna. *Internal lateral,* much stronger, consists of two portions; *anterior* arises from fore part of internal condyle to be inserted into coronoid process, and *posterior* from back part of condyle to inner margin of olecranon.

Anterior ligament arises above coronoid fossa, and is inserted into coronoid process of ulna and orbicular ligament.

Posterior ligament, attached above olecranon fossa, and below to olecranon process of ulna. The anterior and posterior ligaments become continuous with the lateral to encircle the joint.

The *arteries* are derived from superior and inferior profunda, anastomotica magna, posterior interosseous recurrent, anterior and posterior ulnar recurrent, and radial recurrent.

The *nerves,* from median, ulnar, musculo-cutaneous, and musculo-spiral.

THE RADIO-ULNAR ARTICULATIONS are three—the superior, middle, and inferior.

The *superior radio-ulnar* is a diarthrosis rotatoria, formed by the inner side of the head of radius and lesser sigmoid cavity

of ulna. Its synovial cavity communicates with the elbow-joint and it is held together by the *orbicular,* or *annular ligament,* attached in front and behind to the lesser sigmoid cavity and surrounding the head of radius. Its *arteries* and *nerves* are the same as for elbow.

The *middle radio-ulnar articulation* consists of the *oblique* or *round ligament,* passing from tubercle of ulna to below tuberosity of radius, and the *interosseous* passing between the bones, deficient above for passage of posterior interosseous ves-

FIG 91.

1, anterior ligament; 2 and 2, anterior and posterior portions of internal lateral; 3, orbicular ligament; 4, oblique; 5, interosseous membrane.

sels, and perforated below for anterior vessels. Its *arteries* are from *anterior* interosseous; its *nerves,* from *anterior* and *posterior* interosseous.

Inferior radio-ulnar consists of *anterior* and *posterior radio-ulnar ligaments,* passing from one to the other in front and back of wrist, and *triangular interarticular fibro-cartilage,* interposed between head of ulna and cuneiform bone, and binding the radius and ulna firmly together. Its *arteries* are from anterior and posterior interosseous and carpal; its *nerves,* from median and posterior interosseous.

THE RADIO-CARPAL, or wrist-joint, is a condyloid joint consisting of an elliptical cavity formed by the radius and triangular cartilage, into which fits the convex surfaces of the scaphoid, semi-lunar, and cuneiform below. Its ligaments are external and internal lateral, anterior and posterior radio-carpal.

External lateral passes from the styloid process of radius to the scaphoid, os magnum, and trapezium.

Internal lateral passes from the styloid process of ulna to the cuneiform, pisiform, and annular ligament.

The *anterior radio-carpal* is a broad membrane attached above to the anterior margin of the radius, its styloid process and ulna, and below to cuneiform, semi-lunar, scaphoid, and os magnum, strengthened by a band extending from styloid process of ulna to semi-lunar and cuneiform.

The *posterior radio-carpal* is attached to dorsal margin of radius, and below to cuneiform, semi-lunar, and scaphoid. The anterior and posterior radio-carpal belong to the annular ligament (*vide* fascias).

Its *arteries* are the anterior and posterior carpal, derived from the radial and ulnar, anterior and posterior interosseous, and ascending branches from the deep palmar arch.

Its *nerves* are derived from the median, ulnar, and posterior interosseous.

The *carpal articulations* are arthrodial, and consist of three sets. The first row is held together by two palmar, two dorsal, and two interosseous; the second row by three dorsal, three palmar, and three interosseous; and the two rows are held together by a palmar, dorsal, internal and external lateral ligament.

FIRST ROW.—The *palmar and dorsal ligaments* connect the scaphoid and semi-lunar, and semi-lunar and cuneiform together on the front and back.

The *interosseous* connect the semi-lunar with the scaphoid and cuneiform.

The *pisiform* bone has a separate capsular ligament and an interosseous ligament connecting it to the fifth metacarpal bone and cuneiform.

SECOND ROW.—The *palmar* and *dorsal* ligaments connect the trapezium with the trapezoid, and the os magnum with the trapezoid and unciform, on the front and back of the wrist.

The *interosseous* connect the adjacent surfaces of the trapezium and trapezoid, and the os magnum with the trapezoid and unciform.

TWO ROWS TOGETHER.—The *palmar* and *dorsal* connect the bones of the first with the second rows on the front and back

of the wrist. The *internal lateral* passes on the ulnar side between the cuneiform and unciform. The *external lateral,* stronger, passes on the radial side between the scaphoid and trapezium.

The *anterior annular* ligament contributes strength to these joints.

The *arteries* are: Carpal of anterior interosseous, anterior and posterior carpals of radial and ulnar, carpal of deep palmar arch, interosseous recurrent, and terminal branches of anterior and posterior interosseous.

The *nerves* are from median, ulnar, and posterior interosseous.

THE CARPO-METACARPAL ARTICULATIONS are each arthrodial joints, held together by dorsal, palmar, interosseous, and capsular ligaments, except the thumb, which has only capsular.

The *capsular* ligament of the thumb surrounds the margins of the articular surfaces of the first metacarpal and trapezium, and is lined by a separate synovial sac.

The *palmar and dorsal carpo-metacarpal* connects the carpus and metacarpus on the palmar and dorsal surface.

The *interosseous* connect the adjoining inferior angles of os magnum and unciform with the contiguous surfaces, fourth and fifth metacarpal bones.

The *synovial membranes* of the wrist consist of five distinct sacs: First, *membrana sacciformis* lines lower end of ulna, sigmoid cavity of radius, and upper surface of triangular cartilage; second, lower surface of radius and cartilage and upper surface of first row of carpus; third, between margins of carpus and carpo-metacarpal joints; fourth, between carpo-metacarpal joint of thumb; and fifth, between pisiform and cuneiform.

Intermetacarpal Articulation.—The bases of the metacarpal bones, except the thumb, articulate with one another by arthrodial joints, lined by synovial membrane continuous with the carpal sac and connected together by palmar, dorsal, and interosseous ligaments. The digital extremities are connected by a transverse ligament across the anterior surface, continuous with anterior metacarpo-phalangeal ligament.

THE METACARPO-PHALANGEAL and PHALANGEAL are of the condyloid variety, like the wrist-joint, allowing of motion in every direction except laterally. They are each connected by one anterior and two lateral ligaments, the posterior ligament being substituted by the extensor tendon, which crosses the dorsum of the joint.

The *arteries* and *nerves* are from the digitals.

ARTICULATIONS OF THE LOWER EXTREMITY.

THE HIP-JOINT is a true enarthrodial articulation, formed above by deep cup-like cavity of acetabulum, below by prominent spherical head of femur. Its ligaments are the capsular, ilio-femoral, teres, cotyloid, and transverse.

The *capsular* ligament, dense and strong, is attached above to margin of acetabulum and cotyloid ligament, and below to the spiral line in front and to the neck behind. It is strengthened by several accessory bands, the *pubo-femoral, ilio-trochanteric, ischio-capsular,* and *ilio-femoral.* Of these the latter is the most important, arising above from anterior inferior spine, and attached below to spiral line, and has received the name of Y-ligament of Bigelow.

The *ligamentum teres,* or round ligament, is a strong triangular band, its base arising from the bottom of acetabulum and margins of cotyloid notch externally, its apex inserted below and behind centre of head of femur.

The *cotyloid ligament* encircles and deepens the acetabulum, and at the inner side, under the name of the *transverse ligament,* it bridges over the cotyloid notch, converting it into a foramen for the passage of nutrient vessels to the joint.

There are numerous bursa about the joint, with one of which, beneath the ilio-psoas muscle, the synovial membrane often communicates.

Its *arteries* are derived from the sciatic, internal and external circumflex, obturator, and gluteal.

Its *nerves* are derived from the great sciatic, obturator, accessory obturator, and the sacral plexus.

THE KNEE-JOINT is a ginglymoid articulation, formed above by condyles of femur, below by head of tibia, and in front by patella.

Its *ligaments* are divided into two sets, the external, consisting of anterior, posterior, internal lateral, two external laterals, and capsular; and internal, consisting of anterior, posterior, two semi-lunar fibro-cartilages, transverse, coronary, ligamentum mucosum, and ligamenta alaria. Its joint surface is the most extensive in the body.

External Set.—Anterior, or *ligamentum patella,* is the tendinous portion of extensors of thigh between patella and tubercle of tibia. The *posterior,* or *ligamentum posticum Winslowii,* derived principally from the tendon of semi-membranosus, arises from inner tuberosity of tibia, passes upward and outward to be inserted into external condyle of femur.

The *internal lateral* is a flat and broad ligament arising from back part of inner condyle of femur, descends forward to be inserted into inner tuberosity of tibia, covering in its course the inferior internal articular artery and nerve, part of tendon of semi-membranosus, and attaching itself to the internal semi-lunar fibro-cartilage.

The *long external lateral ligament,* round and strong, arises from tuberosity on outer part of external condyle, and descends forward to the head of fibula. The *short external lateral ligament* is an accessory, not very constant, band, descending posteriorly to the preceding.

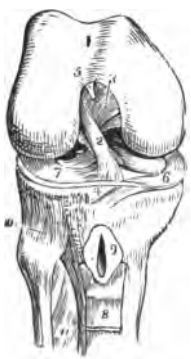


FIG. 92.

2, anterior crucial ligament; 3, posterior crucial ligament; 4, transverse ligament; 6, 7, internal and external semi-lunar cartilages; 8, ligamenta patellæ; 9, bursa patellæ; 10, anterior superior tibio-fibular ligament.

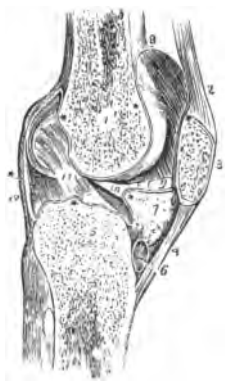


FIG. 93.

2, quadriceps extensor; 3, patella; 4, ligamentum patellæ; 6, bursa; 7, 8, 9, synovial membrane of knee-joint; 10, anterior crucial ligament.

The *capsular ligament* fills up the intervals between the preceding ligaments, and is strengthened by bands from fascia lata, vasti, crureus, semi-membranosus, biceps, and sartorius tendons.

Internal Set.—Crucial ligaments are two strong, short, interosseous, crossing each other from before backward. The *anterior,* or *external,* arises from inner posterior part of condyle of femur, and descends forward and inward to be inserted into front of spine of tibia and internal semi-lunar cartilage.

The *posterior,* or *internal,* arises from outer fore part of inner condyle of femur, descends downward, backward, and outward to spine of tibia.

The *semi-lunar fibro-cartilages* consist of two crescentic laminæ of interarticular cartilage, resting upon the upper articular surface of tibia, which serve to deepen its surface.

The internal is attached by its inner border to internal lateral ligament and to head of tibia by coronary ligaments, its extremities attached in front of anterior crucial ligament and behind the spine.

The external, more circular, is connected to edge of tibial head by coronary ligaments, its extremities being inserted behind and in front of the tibial spine.

In other words, the ends of the semi-lunar cartilages are all, except the anterior end of internal, attached to the tibia between the crucial ligaments.

A band of fibres passing from the anterior margin of external cartilage to the internal has received the name of *transverse ligament.*

The knee is lined by the most extensive synovial membrane in the body, covering both surfaces throughout and extending up between quadriceps tendon and surface of femur.

Below the patella in front is a duplicature of synovial membrane, inclosing some adipose tissue, which has received the name of *ligamentum mucosum,* and extending from it are two fringes—the *ligamenta alaria.*

On either side in the popliteal space behind are bursæ, which often communicate with joint.

There are also bursæ over the patellæ, above and beneath the ligamentum patellæ, and between the inner hamstring and head of tibia.

The *arteries* of the knee-joint are derived from the anastomotica magna, the articular branches of the popliteal (five), and the recurrent branch of the anterior tibial.

Its *nerves* are derived from the anterior crural, obturator, external and internal popliteal nerves.

THE TIBIO-FIBULAR ARTICULATIONS are three—superior, middle, and inferior. The *superior* is an arthrodial joint between fibular head and outer tuberosity of tibia, and consists of *anterior* and *posterior ligaments* stretching on either side of the outer tuberosity, downward and backward, to the head of the fibula. The *arteries* are some of the knee; the *nerves,* from external popliteal.

The *middle* consists of an *interosseous membrane* between the bones, connecting them firmly together, deficient above, for passage forward of anterior tibial artery and below for anterior peroneal vessels.

The *inferior* is an arthrodial joint between contiguous in-

ferior surfaces of tibia and fibula, and consists of four: the *interosseous,* continuous with that above; the *anterior inferior tibio-fibular,* extending downward and outward between tibia and fibula in front; the *posterior inferior tibio-fibular,* occupying a similar position behind; and the *transverse,* a long narrow band, passing between external malleolus and tibia. The synovial membrane is continuous with that of ankle-joint. The *arteries* and *nerves* are the same as those to the ankle.

THE ANKLE-JOINT is a ginglymoid articulation, formed between the lower extremity and malleolus of tibia on the inner side, the malleolus of the fibula on the outer side, and the astragalus below. Its ligaments are anterior, posterior, external, and internal lateral.

The *anterior tibio-tarsal* ligament consists of a broad set of irregular fibres, attached above to lower margin of tibia, below to astragalus. The *posterior tibio-tarsal* ligament passes transversely between back part of tibia and astragalus.

The *internal lateral,* or *deltoid,* has two layers—the superficial triangular, its apex arising from malleolus, its base spread out from before backward to be attached to scaphoid and inferior calcaneo-scaphoid ligament, the sustentaculum, and inner side of astragalus; and the deep, a short, round cord passing from internal malleolus to astragalus.

The *external lateral ligament* consists of three distinct fasciculi, anterior, middle, and posterior, arising from near summit of external malleolus, and being inserted respectively into the front of astragalus, the outer surface of os calcis, and the back of astragalus.

The *arteries* of the ankle-joint are derived from the malleolar branches of the peroneal and anterior tibial.

Its *nerves* are branches of the anterior and posterior tibial nerves.

THE ARTICULATIONS OF THE TARSAL BONES consist of those of the first row, those of the second row, and of the two rows with each other.

FIRST ROW.—The astragalus articulates with the calcaneum by two distinct surfaces separated by the interosseous groove, and firmly connected by the *external* and *posterior calcaneo-astragaloid ligaments,* and the *interosseus.* The external calcaneo-astragaloid ligament passes vertically downward from the outer surface of astragalus to outer surface of calcaneum. The posterior is a short, narrow, oblique band connecting the posterior border of astragalus to the os calcis.

The *interosseus* is a strong, short ligament passing vertically and obliquely downward between the two bones, the principal bond of union.

The *arteries* of the first row are tarsal from dorsalis pedis, external malleolar from anterior tibial, and branches of peroneal from posterior tibial.

Nerves, from posterior tibial, or plantar.

THE SECOND ROW are firmly held together by *dorsal, plantar,* and *interosseous* ligaments. The two former unite the dorsal and plantar surfaces and the interosseous, four strong bands connect the scaphoid and cuboid, the internal and middle, the middle and external cuneiforms, and the external cuneiform and cuboid.

The *arteries* of the second row are from plantars and metatarsals. *Nerves,* from anterior tibial, and internal and external divisions of posterior tibial nerves.

THE TWO ROWS OF THE TARSUS are connected with each other by three sets of ligaments, first between os calcis and cuboid, consisting of *superior* and *internal calcaneo-cuboid, long* and *short calcaneo-cuboid;* second, between os calcis and scaphoid, consisting of *superior* and *inferior calcaneo-scaphoid;* and third, between astragalus and scaphoid, consisting of a single *superior astragalo-scaphoid ligament,* a band passing from neck of astragalus to upper surface of scaphoid.

Calcaneo-cuboid.—The *superior* passes between dorsal surfaces of os calcis and cuboid. The *internal,* passing from os calcis to inner side of cuboid, is one of the main bonds of union between the two rows of tarsus.

The *inferior* firmly connects the bones below, the *ligamentum longæ plantæ* passing from os calcis forward to the plantar surface of the cuboid, and sending fibres forward to bases of second, third, and fourth metatarsal bones; the *ligamentum breve plantæ* passing from fore and under surface of os calcis to under surface of cuboid. The two preceding are important in preserving the arch of the foot.

The *superior* and *inferior calcaneo-scaphoid* pass above and below these bones, firmly connecting them.

The *arteries* of the mediotarsal joints are derived from the anterior tibial, tarsal, metatarsal, or external plantar.

Nerves, from external branch of anterior tibial.

THE TARSO-METATARSAL ARTICULATIONS are firmly held together by *dorsal* and *plantar* ligaments, and connected with one another by *interosseous bands,* three in number, passing between internal cuneiform and second metatarsal bone, external cuneiform and second metatarsal, and external cuneiform and third metatarsal.

The *arteries* are from metatarsal, dorsalis pedis, and deep plantar arch;

The *nerves,* from anterior tibial, and internal and external plantars.

Intermetatarsal Articulations.—The bases of all except the first are connected by *dorsal plantar* and *interosseous* ligaments, and the distal extremities are connected by the transverse metatarsal ligament.

THE SYNOVIAL MEMBRANES concerned in these articulations are six: (1) between calcaneo-astragaloid articulation, posterior to interosseous membrane; (2) anterior calcaneo-astragaloid and astragalo-scaphoid; (3) calcaneo-cuboid; (4) between middle and external cuneiform, scaphoid, and three cuneiforms, middle and external cuneiform, and second and third metatarsal, and between cuboid and external cuneiform and scaphoid; (5) between internal cuneiform and first metatarsal; and (6) between cuboid and fourth and fifth metatarsal bones.

THE METATARSO-PHALANGEAL ARTICULATIONS are each connected by *two lateral* and a *plantar ligament,* and the phalangeal articulations are the same, the extensor tendons acting as dorsal ligaments. They resemble in every respect the articulations in the hand (*vide* hand).

THE MUSCULAR SYSTEM.

THE muscles constitute 45 per cent. of the body-weight and are the active agents of locomotion.

They consist of two kinds—the NON-STRIPED and the STRIPED. The latter, being usually under the control of the will (the heart being a notable exception), have also received the name of *voluntary,* and the former, not under the control of the will, *involuntary.*

Microscopically, their *structure* is as follows:—

Non-striped muscular tissue is made up of elongated, contractile, nucleated cells. They consist of minute fibres in bundles, inclosed in extremely delicate sheaths of elastic tissue.

They are held together by an albuminous cement and collected by connective tissue, into groups or masses, one-tenth to one five-hundredth of an inch in length.

Non-striped muscular tissue is highly vascular and is supplied with nerves from the sympathetic.

Striped muscular tissue is made up of cylindroid fibres of from one and a half to two inches in length and one two-hundredth to one six-hundredth of an inch in diameter. They are held together in bundles by the *endomysium,* a delicate fibro-connective tissue. These bundles are collected into groups by the *perimysium,* a stronger connective-tissue band, forming the fasciculi of the fully formed muscle. Striped muscular tissue is also highly vascular.

The parts of an individual fibre are—first, the *sarcolemma,* a very delicate, transparent, elastic sheath; second, the *membranes of Krause,* which appear as dark lines stretching across the fibre at regular intervals, forming the third, or the *compartments of Krause,* which contain the muscular substance. The latter contain the nucleated *muscle-corpuscles.*

The striped muscular fibres of the heart differ somewhat from the preceding, being branched, and dividing and subdividing to form an intricate net-work.

The muscles are connected to cartilages, ligaments, bones, and skin, either directly or by aponeuroses or tendons.

Aponeuroses are dense, white, fibrous membranes, serving to connect the muscles with the structures to be acted upon.

Tendons are white, fibrous, glistening cords. They are composed of white, fibrous tissue, arranged into bands or bundles.

They are attached to the perichondrium, periosteum, ligaments, and subcutaneous tissue by a mutual interlacement of fibres.

Names of Muscles.—They have received their names:—

1. From the arrangement of their fibres they have received the names of radiated, penniform, bipenniform, etc.
2. From their uses they are called extensors, adductors, etc.
3. From their direction, oblique, rectus, transversalis, etc.
4. From the number of insertions, as triceps, biceps, etc.
5. From their form, as rhomboid, deltoid, etc.
6. From their attachment, as occipito-frontalis, sterno-hyoid, etc.

The origin refers to the fixed extremity; the insertion, to the movable point.

Muscles of the Head.

CRANIAL REGION.

Occipito-frontalis.—*Origin,* by two bellies, one from outer two-thirds of superior curved line of the occipital bone and base of the mastoid process of the temporal, the other from corrugator supercilii, orbicularis palpebrarum, and pyramidalis nasi fibres; *insertion,* into fibrous aponeurosis covering the vertex of the skull; *action,* raises the eyebrows and used chiefly as a muscle of facial expression; *nerves,* supraorbital, small occipital, facial, and posterior auricular branch of facial.

AURICULAR REGION.

Attollens Aurem.—*Origin,* from aponeurosis of occipito-frontalis; *insertion,* into the surface of the pinna; *action,* raises the ear; *nerve,* occipitalis minor.

Attrahens Aurem.—*Origin,* from edge of occipito-frontalis aponeurosis; *insertion,* into anterior part of helix; *action,* draws the ear upward and forward; *nerve,* facial.

Ratrahens Aurem.—*Origin,* from mastoid portion of temporal bone; *insertion,* into lower part of concha; *action,* draws the ear backward; *nerve,* posterior auricular branch of facial.

PALPEBRAL REGION.

Orbicularis Palpebrarum.—*Origin,* from nasal process of superior maxilla, internal angular process of frontal, and from front and sides of tendo-palpebrarum; *insertion,* into skin of the cheek, eyelids, forehead, and temple, blending with the corrugator supercilii and the occipito-frontalis; *action,* sphincter of the eyelids; *nerve,* facial.

TENDO PALPEBRARUM (TENDO OCULI).—*Origin,* nasal process of superior maxilla; *insertion,* inner part of tarsal cartilage.

CORRUGATOR SUPERCILII.—*Origin,* superciliary ridge; *insertion,* into orbicularis about the middle of the orbital arch; *action,* draws eyebrows inward and downward and wrinkles the forehead; *nerve,* facial.

TENSOR TARSI.—*Origin,* from crest and orbital surface of lachrymal gland; *insertion,* into tarsal cartilages near the puncta lachrymalia; *action,* draws the lachrymal canals inward and against the globe of the eye; *nerve,* facial.

ORBITAL REGION.

LEVATOR PALPEBRÆ SUPERIORIS.—*Origin,* from lesser wing of the sphenoid, near the optic foramen; *insertion,* superior border of tarsal cartilage; *action,* elevates the upper eyelid; *nerve,* third cranial, or motor oculi.

RECTUS SUPERIOR.—*Origin,* sheath of the optic nerve and upper margin of optic foramen; *insertion,* into upper surface of sclerotic coat; *action,* rotates the eyeball upward; *nerve,* third cranial.

RECTUS INFERIOR.—*Origin,* from lower and inferior part of optic foramen (ligament of Zinn); *insertion,* into lower surface of sclerotic; *action,* rotates the eyeball downward; *nerve,* third cranial.

RECTUS INTERNUS.—*Origin,* same as rectus inferior; *insertion,* into inner surface of sclerotic; *action,* rotates the eyeball inward; *nerve,* third cranial.

RECTUS EXTERNUS.—*Origin,* by two heads—lower from ligament of Zinn and lower margin of sphenoidal fissure, upper from outer margin of optic foramen; *insertion,* into outer surface of sclerotic; *nerve,* abducens, or sixth cranial. Passing between the two heads are the ophthalmic vein, the third, nasal branch of fifth, and sixth nerves.

SUPERIOR OBLIQUE.—*Origin,* from inner margin of optic foramen: its tendon passes through a pulley near the internal angular process of the frontal bone; *insertion,* into sclerotic, between external and superior recti, midway between entrance of optic nerve and the cornea; *action,* rotates the eyeball on its axis; *nerve,* fourth, or patheticus.

INFERIOR OBLIQUE.—*Origin,* orbital plate of superior maxilla; *insertion,* near that of superior oblique, between external and superior recti; *action,* rotates the eyeball on its axis; *nerve,* third cranial.

NASAL REGION.

PYRAMIDALIS NASI.—*Origin,* from the occipito-frontalis; *insertion,* into the compressor nasi; *action,* lowers the inner angle of the eyebrows; *nerve,* facial.

LEVATOR LABII SUPERIORIS ALÆQUE NASI.—*Origin,* nasal process of superior maxilla; *insertion,* the ala of the nose and upper lip, blending with the levator labii oris proprius and orbicularis; *action,* dilates the nostril and elevates the upper lip; *nerve,* facial.

DILATOR NARIS POSTERIOR.—*Origin,* nasal notch of superior maxilla; *insertion,* into skin at the margin of the nostril.

DILATOR NARIS ANTERIOR.—Origin, from cartilage of the ala; *insertion,* into the skin of nose; *action,* dilates the nostrils; *nerve,* facial.

COMPRESSOR NASI.—*Origin,* superior maxilla, near the incisive fossa; *insertion,* into fibro-cartilage of the nose, continuous with the pyramidalis nasi aponeurosis and its fellow; *action,* dilates the nostril; *nerve,* facial.

COMPRESSOR NARIUM MINOR.—*Origin,* from alar cartilage; *insertion,* into the skin of the end of the nose; *action,* dilates the nostril; *nerve,* facial.

DEPRESSOR ALÆ NASI.—*Origin,* incisive fossa of superior maxilla; *insertion,* into the ala of the nose; *action,* contracts the nostril; *nerve,* facial.

MAXILLARY REGION.

LEVATOR LABII SUPERIORIS (PROPRIUS).—*Origin,* above infraorbital foramen to malar and superior maxilla; *insertion,* into the upper lip; *action,* elevates the upper lip; *nerve,* facial.

LEVATOR ANGULI ORIS.—*Origin,* from canine fossa; *insertion,* into the angle of the mouth, blending the depressor anguli oris, orbicularis, and zygomatici; *action,* draws the angle inward and raises it; *nerve,* facial.

ZYGOMATICUS MAJOR.—*Origin,* from malar bone; *insertion,* into angle of mouth, blending with depressor anguli oris and orbicularis.

ZYGOMATICUS MINOR.—*Origin,* from malar bone; *insertion,* at the angle of the mouth, blending with the levator superioris; *action,* draws the lip outward and upward; *nerve,* facial.

LEVATOR LABII INFERIORIS.—*Origin,* from incisive fossa of lower jaw; *insertion,* into the skin of the chin; *action,* raises the lower lip; *nerve,* facial.

DEPRESSOR LABII INFERIORIS.—*Origin,* from external oblique line of lower jaw; *insertion,* into skin of lower lip, blending with its fellow and the orbicularis; *action,* lowers the angle of the mouth; *nerve,* facial.

DEPRESSOR ANGULI ORIS.—*Origin,* external oblique line of lower jaw; *insertion,* into the angle of the mouth, continuous with the orbicularis and risorius at its insertion and the platysma at its origin; *action,* depresses the angle of the mouth; *nerve,* facial.

ORBICULARIS ORIS.—*Origin,* by accessory fibres (accessorii orbicularis superioris and inferioris and naso-labialis), from superior and inferior maxillary borders and nasal septum; *insertion,* into the buccinator and adjoining muscles, forming the sphincter of the mouth; *action,* closes the lips; *nerve,* facial.

BUCCINATOR.—*Origin,* from pterygo-maxillary ligament and the posterior alveolar processes of the upper and lower jaw; *insertion,* into orbicularis oris; *action,* compresses and contracts the cheeks; *nerves,* facial and buccal branch of the inferior maxillary nerve.

RISORIUS (SANTORINI).—*Origin,* from fascia of masseter muscle; *insertion,* at angle of the mouth; *action,* draws back the angles of the mouth,—the "smiling" muscle; *nerve,* facial.

MASSETER: SUPERFICIAL PORTION.—*Origin,* inner surface of zygoma and malar process of superior maxilla; *insertion,* into the ramus and angle of the lower jaw.

DEEP PORTION.—*Origin,* posterior border and inner surface of the zygoma; *insertion,* into the ramus and coronoid process of the jaw; *action,* raises the lower jaw, and the superficial portion assists in drawing it forward; *nerve,* inferior maxillary.

TEMPORAL.—*Origin,* from the temporal fascia and the temporal fossa; *insertion,* into the coronoid process of the lower jaw; *action,* raises and draws backward the lower jaw; *nerve,* inferior maxillary.

INTERNAL PTERYGOID.—*Origin,* from pterygoid fossa and the tuberosity of the palate-bone; *insertion,* into the inner side of the ramus and angle of the lower jaw; *action,* draws forward and raises the lower jaw; the accessory triturating muscle of mastication; *nerve,* inferior maxillary.

EXTERNAL PTERYGOID.—*Origin,* by two heads—the lower from the tuberosities of the palate and superior maxilla and from the external pterygoid plate, the upper from the pterygoid ridge on the greater wing of the sphenoid; *insertion,* into the front of the neck of the lower jaw and inner side of interarticular cartilage; *action,* draws the jaw forward; triturating muscle of mastication; *nerve,* inferior maxillary.

Muscles of the Ear (*vide* Ear).

Muscles of the Neck.

SUPERFICIAL CERVICAL REGION.

Platysma Myoides.—*Origin,* from the deep fascia over the trapezius, deltoid, and pectoral muscles, and from the clavicle and acromion; *insertion,* into the lower jaw and skin of the face; *action,* wrinkles the skin of the neck and protects the air-passages and blood-vessels from external pressure,—rudimentary in man; *nerves,* branch of superficial cervical plexus and the facial.

Sterno-cleido-mastoid.—*Origin,* by two heads — sternal portion from the fore and upper part of the manubrium sterni, the clavicular portion from the inner third of the upper border of the clavicle, leaving a triangular interval; *insertion,* into the mastoid process and outer two-thirds of the superior curved line of the occipital bone; *action,* rotates and depresses the head; *nerves,* spinal accessory and branches of the cervical plexus.

INFRA-HYOID REGION.

Sterno-hyoid.—*Origin,* from upper and back part of the manubrium sterni and inner extremity of the clavicle; *insertion,* into the lower border of the os hyoides; *action,* depresses the hyoid bone; *nerve,* branch from the loop of communication between the descendens and communicans noni.

Sterno-thyroid.—*Origin,* posterior surface of manubrium sterni; *insertion,* into oblique line of the surface of the thyroid cartilage; *action,* depresses the larynx; *nerve,* branch from the communicating loop above.

Thyro-hyoid.—*Origin,* from the oblique line on the surface of the thyroid cartilage; *insertion,* into the greater cornu and body of the hyoid bone; *action,* elevates the larynx; *nerve,* hypoglossal.

Omo-hyoid.—*Origin,* from the upper border of the scapula and the transverse ligament; *insertion,* into the lower border of the os hyoides; its centre is tendinous and bound down to the cartilage of the first rib by a process of the deep cervical fascia; *action,* depresses the hyoid bone and draws it backward; *nerve,* from the communicating loop above.

SUPRA-HYOID REGION.

Digastric.—*Origin,* by two bellies—posterior from digastric groove of mastoid process of the temporal bone, anterior

from a depression in the lower border of the jaw near the symphysis; the tendon is held to the hyoid bone by an aponeurotic loop and pierces the stylo-hyoid; *action,* raises the tongue and hyoid bone; *nerve,* mylo-hyoid branch of the inferior dental and facial.

STYLO-HYOID.—*Origin,* from outer surface of styloid process; *insertion,* into the body of the hyoid bone; *action,* retracts and elevates the hyoid bone; *nerve,* facial: near its insertion it is perforated by the tendon of the digastric.

MYLO-HYOID.—*Origin,* from the mylo-hyoid ridge of the inferior maxilla from last molar to symphysis; *insertion,* into a fibrous raphé in the median line, extending from the hyoid bone to the chin and into the body of the hyoid bone; *action,* draws forward and elevates the hyoid bone and forms part of the floor of the mouth; *nerve,* mylo-hyoid branch of the inferior dental.

GENIO-HYOID.—*Origin,* from inferior genial tubercle of the internal surface of the symphysis of the jaw; *insertion,* into the front of the body of the hyoid bone; *action,* same as the mylo-hyoid; *nerve,* hypoglossal.

MUSCLES OF THE TONGUE.

GENIO-HYOGLOSSUS.—*Origin,* from superior genial tubercle of the internal surface of the symphysis of the jaw; *insertion,* by fan-like expansion into the whole length of the inferior surface of the tongue, the side of the pharynx, and the body of the hyoid bone; *action,* retracts and protrudes the tongue; *nerve,* the hypoglossal.

HYPOGLOSSUS.—*Origin,* body and greater cornu of the hyoid bone; *insertion,* between the lingualis and styloglossus into the side of the tongue; *action,* renders the tongue convex from side to side; *nerve,* hypoglossal.

STYLOGLOSSUS.—*Origin,* from stylomaxillary ligament and styloid process of the temporal; *insertion,* into the side of the tongue, blending with the hyoglossus and lingualis; *action,* retracts and elevates the tongue; *nerve,* hypoglossal.

LINGUALIS.—Consists of four portions—superficial, inferior, transverse, and vertical. It lies between the genio-hyoglossus and the hyoglossus, extending from the apex to the base of the tongue; *action,* renders the tongue convex from before backward; *nerve,* the chorda tympani.

PALATO-GLOSSUS (CONSTRICTOR ISTHMI FAUCIUM) (*vide* PALATAL REGION).

PHARYNGEAL AND PALATAL REGION.

CONSTRICTOR SUPERIOR.—*Origin,* from margin of internal pterygoid plate and its hamular process; from pterygo-maxillary ligament, part of the alveolar process of the lower jaw and side of the tongue, tendon of the tensor palati, and part of the palate-bone; *insertion,* into the median raphé and the pharyngeal spine of the basilar process of the occipital bone; *action,* constricts the pharynx; *nerves,* pharyngeal plexus and glosso-pharyngeal.

CONSTRICTOR MEDIUS.—*Origin,* from the stylo-hyoid ligament, greater and lesser cornua of the hyoid bone; *insertion,* into the median fibrous raphé, blending with its fellow of opposite side; *action,* constricts the pharynx; *nerves,* pharyngeal plexus and glosso-pharyngeal.

CONSTRICTOR INFERIOR.—*Origin,* from the sides of the thyroid and cricoid cartilages; *insertion,* into the fibrous raphé of the pharynx; *action,* contracts the pharyngeal canal; *nerves,* external laryngeal, glosso-pharyngeal, pharyngeal plexus.

STYLO-PHARYNGEUS.—*Origin,* from base of the styloid process; *insertion,* into the constrictor muscles, palato-pharyngeus, and posterior border of the thyroid cartilage; *nerves,* pharyngeal plexus and glosso-pharyngeal.

LEVATOR PALATI.—*Origin,* cartilaginous portion of Eustachian tube and apex of the petrous portion of the temporal bone; *insertion,* into the back part of the soft palate, blending with its fellow of the opposite side; *action,* elevates the soft palate; *nerve,* descending palatine from Meckel's ganglion, from the facial.

TENSOR PALATI, OR CIRCUMFLEXUS.—*Origin,* from spine of the sphenoid, vaginal portion of temporal bone, cartilage of Eustachian tube, and scaphoid fossa at base of internal pterygoid plate; *insertion,* into the palate-bone and the soft palate; *action,* renders tense the palate; *nerve,* a branch from the otic ganglion.

AZYGOS UVULÆ, OR LEVATOR.—*Origin,* from aponeurosis of soft palate and posterior nasal spine; *insertion,* into the uvula; *action,* raises the palate; *nerves,* descending palatine branches and Meckel's ganglion, from the facial.

PALATO-GLOSSUS (CONSTRICTOR ISTHMI FAUCIUM).—*Origin,* from soft palate on either side of the uvula; *insertion,* into the dorsum and side of the tongue, blending with the fibres of the styloglossus—this muscle forms the anterior pillar of the fauces; *action,* constricts the fauces; *nerves,* palatine branches of Meckel's ganglion.

PALATO-PHARYNGEUS.—*Origin,* by two portions, from soft palate; *insertion,* into posterior border of thyroid cartilage and pharynx; this muscle forms the posterior pillar of the fauces; *action,* closes the posterior nares; *nerves,* palatine branches from Meckel's ganglion.

VERTEBRAL REGION.

RECTUS CAPITIS ANTICUS MAJOR.—*Origin,* by four tendons from transverse processes of the third, fourth, fifth, and sixth cervical vertebræ; *insertion,* basilar process of occipital bone; *action,* flexes the head; *nerves,* suboccipital and deep internal branches of cervical plexus.

RECTUS CAPITIS ANTICUS MINOR.—*Origin,* from root of transverse process and anterior part of the lateral mass of the atlas; *insertion,* basilar process of occipital, behind the former; *action,* flexes the head; *nerves,* suboccipital and deep branches of the cervical plexus.

RECTUS LATERALIS.—Origin, superior surface of the transverse process of the atlas; *insertion,* inferior surface of the jugular process of the occipital; *action,* draws the head laterally; *nerves,* suboccipital and deep internal branches of the cervical plexus.

LONGUS COLLI.—*Origin,* from three portions, superior oblique portion from anterior tubercles of the transverse processes of the third, fourth, and fifth cervical; *insertion,* tubercle on the anterior arch of atlas; inferior oblique portion, *origin,* from anterior surface of the bodies of the first two or three dorsal vertebræ; *insertion,* anterior tubercles of the transverse processes of the fifth and sixth cervical; vertical portion, *origin,* from the anterior surface of the bodies of the lower three cervical and upper three dorsal bodies of the second, third, and fourth cervical vertebræ; *action,* rotates and flexes the cervical portion of the vertebræ; *nerves,* anterior branches of the lower cervical nerve.

SCALENUS ANTICUS.—*Origin,* from the tubercle of the first rib; *insertion,* into the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ; *action,* flexes and rotates the vertebral column; *nerves,* anterior branches of the lower cervical nerve.

SCALENUS MEDIUS.—*Origin,* upper surface of the first rib, behind the groove for the subclavian artery; *insertion,* into the transverse processes of the lower six cervical vertebræ; *action,* rotates and flexes the vertebral column; *nerves,* the anterior branches of the lower cervical nerve: the posterior thoracic, long thoracic nerve, or external respiratory nerve of Bell, has its

origin in the substance of this muscle, by union of two roots from fifth and sixth cervical nerves.

SCALENUS POSTICUS.—*Origin,* from the outer surface of the second rib, behind the serratus magnus; *insertion,* into the posterior tubercles of the transverse processes of the lower two or three cervical vertebræ; *action,* flexes and rotates the spine; *nerves,* anterior branches of the lower cervical nerves.

Of these muscles the scalenus medius is the longest and largest, and the scalenus posticus the smallest.

MUSCLES OF THE LARYNX AND EPIGLOTTIS (*vide* LARYNX).

MUSCLES OF THE TRUNK.

MUSCLES OF THE BACK.

First Layer.

TRAPEZIUS.—*Origin,* from inner third of superior curved line of the occipital bone, the ligamentum nuchæ, the spinous processes of the seventh cervical, and all the dorsal vertebræ; *insertion,* into the outer third of the posterior border of the clavicle, the inner margin of the acromion process, and the crest of the spine of the scapula; *action,* draws the head backward; *nerves,* cervical plexus and spinal accessory.

LIGAMENTUM NUCHÆ.—*Origin,* from external occipital protuberance; *insertion,* spinous processes of the cervical vertebræ, from the second to the seventh. This ligament is rudimental in man, and in the lower animals sustains the head.

LATISSIMUS DORSI.—*Origin,* by an aponeurosis from the spinous processes of the six lower dorsal, the lumbar and sacral vertebræ, the supraspinous ligament, the crest of the ilium, and the three or four lower ribs; *insertion,* into the inner lip of the bicipital groove of the humerus, in front of the teres major, and a little above the pectoralis major; the tendon of this muscle twists completely on itself, so that the superior fibres become the inferior; *action,* draws the arm backward and downward, or, fixing the arm, raises the lower ribs and draws the trunk forward; *nerve,* subscapular.

Second Layer.

LEVATOR ANGULI SCAPULÆ.—*Origin,* from three to five tendons from the posterior tubercles of the transverse processes of the three or five upper cervical vertebræ; *insertion,* into posterior border of the scapula, at the root of the spine; *action,*

elevates the angle of the scapula; *nerve,* interior division of the third and fourth cervical nerves.

RHOMBOIDEUS MINOR.—*Origin,* from spinous processes of seventh cervical and first dorsal vertebræ and the ligamentum nuchæ; *insertion,* into root of the spine of the scapula; *action,* draws the inferior angle upward and backward; *nerves,* branches from the fifth cervical nerve.

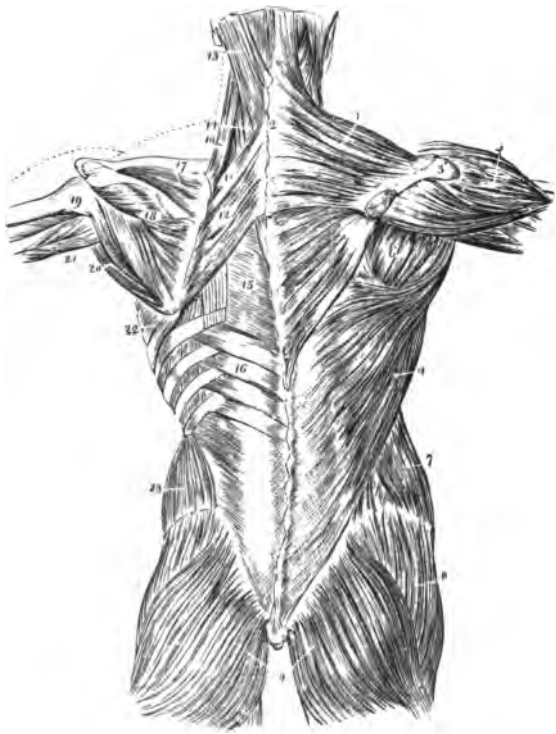


FIG. 94.

Muscles of the back: 1, trapezius; 2, 4, latissimus dorsi; 10, levator anguli scapulæ; 11, rhomboideus minor; 12, rhomboideus major; 13, 14, splenius capitis et colli; 15, vertebral aponeurosis; 16, serratus posticus inferior.

RHOMBOIDEUS MAJOR.—*Origin,* from supraspinous ligament and spinous processes of four or five upper dorsal vertebræ; *insertion,* by a tendinous arch attached above near the spine and below to the inferior angle of the scapula; *action,* draws the

inferior angle upward and backward; *nerves,* branches of the fifth cervical.

Third Layer.

SERRATUS POSTICUS SUPERIOR.—*Origin,* from spinous processes of the two or three upper dorsal and last cervical vertebræ, and from the ligamentum nuchæ; *insertion,* into upper borders of the second to the fifth ribs inclusive; *action,* assists in respiration; *nerves,* external branches of the posterior division of the cervical.

SERRATUS POSTICUS INFERIOR.—*Origin,* from spinous processes and interspinous ligaments of two or three upper lumbar and two lower dorsal vertebræ; *insertion,* into lower borders of the four lower ribs, external to their angles; *action,* elevates the ribs; assists in respiration; *nerves,* external branches of the posterior divisions of the lower dorsal.

SPLENIUS.—*Origin,* from spinous processes of last cervical and six upper dorsal vertebræ, the lower half of the ligamentum nuchæ, and the supraspinous ligament; *insertion,* by two heads—splenius capitis into the occipital bone, just below the superior curved line and the mastoid process of the temporal bone; splenius colli into posterior tubercles of the transverse processes of the three or four upper cervical vertebræ; *action,* separately, rotates the head and draws it to the other side; together, draw the head backward; *nerves,* external branches of the posterior divisions of the cervical.

Fourth Layer.

ERECTOR SPINÆ.—*Origin,* from sacro-iliac groove and from a broad tendon attached internally to the spinous processes of the lumbar and two or three lower dorsal vertebræ and supraspinous ligament; externally, the crest of the ilium and the posterior part of the sacrum; *insertion,* by two parts—1, sacro-lumbalis (ilio-costalis), inserted into the angles of the six or seven lower ribs; this muscle has two accessory portions, *(a)* musculus accessorius ad sacro-lumbalem: *origin,* from angle of six lower ribs; *insertion,* angles of six upper ribs; *(b)* cervicalis ascendens: *origin,* angles of the four or five upper ribs; *insertion,* into the posterior tubercles of the fourth to the sixth cervical vertebræ, inclusive; 2, longissimus dorsi; *insertion,* into the transverse processes of all the dorsal vertebræ, and from the seventh to the eleventh ribs, inclusive, between their angles and tubercles; *action,* bends the trunk backward and erects the spine; *nerves,* external branches of the posterior divisions of the lumbar and dorsal.

TRANSVERSALIS COLLI (OR CERVICIS).—*Origin,* transverse processes of six upper dorsal vertebræ; *insertion,* into the posterior tubercles of the transverse processes of the second to the sixth cervical vertebræ inclusive; *nerves,* external branches of the posterior divisions of the cervical.

TRACHELO-MASTOID.—*Origin,* from articular processes of three or four lower cervical, and from the transverse processes of the third to the sixth dorsal vertebræ; *insertion,* into the posterior margin of the mastoid process, below the sterno-mastoid and the splenius; *action,* steadies the head; *nerves,* external branches of the posterior divisions of the cervical.

SPINALIS DORSI.—*Origin,* spinous processes of last two dorsal and first two lumbar vertebræ; *insertion,* into spinous processes of the dorsal vertebræ, blending with the semi-spinalis dorsi; action, erects the spinal column; *nerves,* external branches of the posterior divisions of the cervical.

SPINALIS COLLI.—*Origin,* from the spinous processes of the fifth to the seventh cervical vertebræ; *insertion,* into the spinous process of the axis; *action,* steadies the neck; *nerves,* same as above; this muscle is absent in 20 per cent. of the subjects.

COMPLEXUS.—*Origin,* by seven tendons from transverse processes of the upper three dorsal and seventh cervical and articular processes of the fourth, fifth, and sixth cervical; *insertion,* into the occipital bone, between the curved lines; *action,* separately, rotates and draws the head to one side; together, draw the head directly backward; *nerves,* suboccipital, great occipital, and internal branches of the posterior divisions of the cervical.

Fifth Layer.

SEMI-SPINALES DORSI.—*Origin,* from transverse processes from the fifth to eleventh dorsal vertebræ; *insertion,* into the spinous processes of the lower two cervical and upper four dorsal vertebræ; *action,* erects the spinal column; *nerves,* internal branches of the posterior divisions of the cervical.

SEMI-SPINALES COLLI.—*Origin,* from transverse processes of lower four cervical and upper four dorsal vertebræ; *insertion,* into spinous processes of the second to the fifth cervical vertebræ; *action,* erects the spinal column; *nerves,* same as above.

MULTIFIDUS SPINÆ.—*Origin,* from the transverse processes of the dorsal region, the articular processes in the cervical and lumbar region, the posterior superior of the ilium, posterior sacro-iliac ligaments, and from the aponeurotic arch of the erector spinæ; *insertion,* each fasciculus is attached to the laminæ

and spinous process of the vertebræ above; *action,* preserves the erect condition of the spine; *nerves,* internal branches of the posterior divisions of the cervical, dorsal, lumbar, and sacral nerves.

ROTATORES SPINÆ.—Eleven on either side. *Origin,* from upper part of transverse process; *insertion,* into outer surface and lower border of the laminæ of the vertebræ above, from the first and second dorsal to the eleventh and twelfth; *action,* rotates the spinal column; *nerves,* anterior branches of the posterior divisions of the dorsal.

SUPRASPINALES.—*Origin* and *insertion,* the spinous processes in the cervical region of the vertebræ; *action,* extends cervical spine; *nerves,* internal branches of the posterior divisions of the cervical.

INTERSPINALES.—Consist of muscular bands in pairs between the spinous processes of the adjoining vertebræ: six pairs in the cervical region, three pairs in the dorsal, four or five in the lumbar; *action,* extend the spine; *nerves,* internal branches of the posterior divisions of the cervical, dorsal, and lumbar.

EXTENSOR COCCYGIS.—*Origin,* from the first piece of the coccyx, or last bone of the sacrum; *insertion,* into the lower extremity of the coccyx; *action,* rudimental in man.

INTERTRANSVERSALES.—Are small, muscular bands between the transverse processes: in the cervical region seven pairs, in the dorsal twelve pairs, in the lumbar region four pairs; *action,* flex the spine laterally; *nerves,* internal branches of the posterior division of the cervical, dorsal, and lumbar.

RECTUS CAPITIS POSTICUS MAJOR.—*Origin,* from the spinous process of the axis; *insertion,* into inferior curved line of the occipital bone; *action,* rotates the atlas and the cranium; *nerve,* the suboccipital.

RECTUS CAPITIS POSTICUS MINOR.—*Origin,* from the tubercle of the posterior arch of the atlas; *insertion,* below the inferior curved line of the occipital bone; *action,* draws the head backward; *nerve,* suboccipital.

OBLIQUUS CAPITIS INFERIOR.—*Origin,* spinous process of the axis; *insertion,* lower back portion of the transverse process of the atlas; *action,* rotates the atlas and the cranium; *nerves,* suboccipital and great occipital.

OBLIQUUS CAPITIS SUPERIOR.—From upper surface of the transverse process of the atlas; *insertion,* between the curved lines of the occipital bone to the outer side of the complexus; *action,* rotates the atlas; *nerves,* suboccipital and great occipital.

MUSCLES OF THE ABDOMEN.

OBLIQUUS EXTERNUS.—*Origin,* lower borders of the eight lower ribs; *insertion,* the lowermost muscular fibres, into the anterior half of the iliac crest; the other muscular fibres, by a broad aponeurosis, which joins the anterior half of the aponeurosis of the internal oblique to form the anterior walls of the sheath of the rectus, above into the ensiform cartilage, below into the symphysis pubis. In the median line it blends with its fellow of the opposite side to form the linea alba. A slit in its lower portion above the pubic spine is called the external abdominal ring. The lower thickened portion of the aponeurosis stretching between the anterior superior iliac spine and the pubic spine is called Poupart's ligament. A reflection from it to the ilio-pectineal line is called Gimbernat's ligament; *action,* flexes the pelvis on the thorax, or *vice versa,* and compresses the viscera; *nerves,* lower intercostal, ilio-hypogastric, and ilio-inguinal.

OBLIQUUS INTERNUS.—*Origin,* from the outer half of Poupart's ligament, from the anterior two-thirds of the crest of the ilium, and the posterior lamellæ of the lumbar fascia; *insertion,* above to the lower four costal cartilages, below, conjointly with the tendon of the transversalis, into the os pubis and linea ilio-pectinea, to form the *conjoined tendon,* and into the median line (linea alba) by an aponeurosis extending from the sternum and seventh and eighth costal cartilages to the pubis. This aponeurosis at its lower fourth consists of two united laminæ passing in front of the rectus muscle, but in its upper three-fourths it divides, one lamina passing in front of the rectus and joining the aponeurosis of the external oblique, the other passing behind and joining the aponeurosis of the transversalis; *action,* same as the externus; *nerves,* same as externus.

TRANSVERSALIS.—*Origin,* from outer third of Poupart's ligament and anterior three-fourths of the crest of the ilium, from the inner surface of the cartilages of the six lower ribs, and from the spinous and transverse processes of the lumbar vertebræ; *insertion,* by the conjoined tendon into the linea ilio-pectinea and crest of the os pubis; *action* and *nerves,* same as the externus.

RECTUS ABDOMINIS.—*Origin,* by two tendons—the outer from the crest of the pubis, the inner interlacing with its fellow of the opposite side; *insertion,* into the cartilages of the fifth, sixth, and seventh ribs; *action,* depresses the thorax, flexes the vertebral column, and, acting from above, flexes the pelvis upon the vertebral column.

PYRAMIDALIS.—*Origin,* from the os pubis and anterior pubic ligament; *insertion,* into the linea alba, midway between the os pubis and umbilicus.

QUADRATUS LUMBORUM.—*Origin,* by two portions—posterior portion, from crest of the ilium and ilio-lumbar ligament;

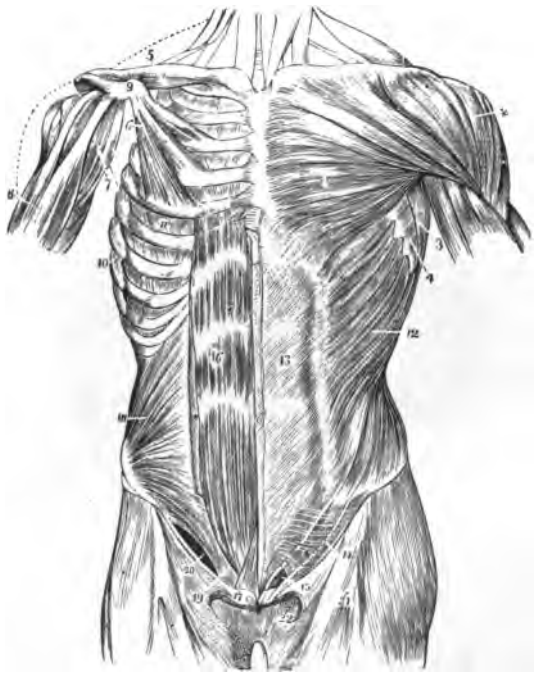


FIG. 95.

Muscles of abdomen: 12, external oblique; 16, rectus abdominis; 18, internal oblique; 17, pyramidalis; 19, quadratus lumborum.

insertion, into lower border of the last rib and transverse processes of the three lower lumbar vertebræ; *origin,* anterior portion, from upper border of the transverse processes of the lumbar vertebræ, from the third to the fifth; *insertion,* into one-half the lower margin of the last rib and apices of upper four lumbar vertebræ; *action,* draws down and fixes the last rib and assists in inspiration and expiration.

MUSCLES OF THE THORAX.

INTERCOSTALES EXTERNI.—Eleven pairs on either side. *Origin,* from the outer border of the groove on the lower border of each rib, from the cartilage to the tubercle; *insertion,* into upper border of the rib below; *action,* raises the ribs; *nerve,* intercostal.

INTERCOSTALES INTERNI.—*Origin,* inner lip of the groove on the lower border of each rib; *insertion,* into the upper border of the rib below; *action,* pulls the ribs upward; *nerve,* intercostal.

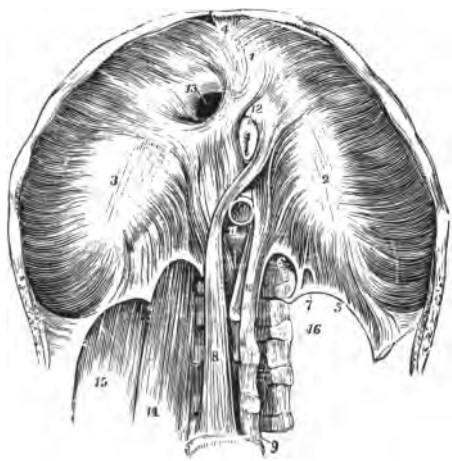


FIG. 96.

Diaphragm: 1, 2, 3, central cordiform tendon; 4, middle leaflet; 5, ligamentum arcuatum externum; 6, ligamentum arcuatum internum; 8, right crus; 10, left crus; 11, aortic opening; 12, œsophageal opening; 13, opening for vena cava; 14, psoas magnus; 15, quadratus lumborum.

INFRACOSTALES (SUBCOSTALES).—*Origin,* inner surface of rib; *insertion,* into the inner surface, from the first to the third rib below; *action,* inspiratory muscles; *nerve,* intercostal.

TRIANGULARIS STERNI.—*Origin,* lower part of the back of the sternum and back of ensiform cartilage and inner surface of sternal end of the costal cartilages of the three or four lower ribs; *insertion,* into the border and inner surfaces of the costal cartilages, from the second to the sixth rib inclusive (it is continuous below with transversalis abdominis muscle); *action,* draws down the costal cartilages; *nerve,* intercostal.

LEVATORES COSTARUM.—Twelve on either side. *Origin,* from transverse processes of seventh cervical and eleven upper dorsal vertebræ; *insertion,* into upper surface of the rib below, between the angle and tubercle; *action,* raises the ribs; *nerve,* the intercostal.

DIAPHRAGMATIC REGION.

DIAPHRAGM.—*Origin,* inner surface of ensiform cartilage, cartilages and bony portions of six or seven lower ribs in front, and from two aponeurotic arches, the ligamentum arcuatum externum and internum and the lumbar vertebræ behind; *insertion,* into the circumference of the central or cordiform tendon; *action,* the principal muscle of inspiration and expulsion; *nerves,* the phrenic, and phrenic plexus of the sympathetic.

THE OPENINGS IN THE DIAPHRAGM.

The *aortic opening* is placed posteriorly between the two crura, in front of the spine. It transmits the aorta, thoracic duct, and vena azygos major, and sometimes the left sympathetic nerve.

The *œsophageal opening* is in front of the decussation of the crura, a little to the left and in front of the aortic opening. It transmits the œsophagus and pneumogastric nerves.

The *foramen quadratum,* or *opening* for the *vena cava,* is placed at the highest part of the central tendon, a little to the right. It transmits the vena cava and maintains its patency. The crus on each side transmits the sympathetic and greater and lesser splanchnic nerves, and in addition the *left* transmits the vena azygos minor.

MUSCLES OF THE PERINEUM (*vide* PERINEUM).

MUSCLES OF THE UPPER EXTREMITY.

MUSCLES OF THE SHOULDER.

PECTORALIS MAJOR.—*Origin,* from the sternal half of the clavicle (clavicular portion) and anterior surface of the sternum and costal cartilages from the second to the sixth or seventh rib (sterno-costal portion); *insertion,* into the anterior bicipital ridge of the humerus; *action,* draws the arm across the chest.

PECTORALIS MINOR.—*Origin,* upper and outer surface of the third to the fifth rib, inclusive, and the aponeurosis of the intercostal muscles; *insertion,* into anterior border of the coracoid process of the scapula; *action,* draws the scapula inward and downward; *nerve,* the anterior thoracic.

SUBCLAVIUS.—*Origin,* from cartilage of the first rib; *insertion,* under surface of the clavicle, about its middle third; *action,* depresses the shoulder, and draws clavicle forward and downward; *nerve,* branch from the union of the fifth and sixth cervical.

SERRATUS MAGNUS.—*Origin,* by nine muscular portions, from the outer surface of the eight upper ribs (two divisions being from the second rib) and from the upper intercostal aponeurosis; *insertion,* by three divisions—upper portion into superior angle of the scapula, middle portion into posterior portion of the scapula between the inferior and superior angles, lower portion into the inferior angle of the scapula; *action,* raises the vertebral border and carries the scapula forward; *nerve,* the posterior thoracic.

DELTOID.—*Origin,* from the outer third of the clavicle and from the outer part of the acromion process and the lower border of the scapular spine; *insertion,* into the outer side of the shaft of the humerus, about its middle into the deltoid tubercle; *action,* raises the arm; *nerve,* the circumflex.

SUBSCAPULARIS.—*Origin,* from the internal two-thirds of the subscapular fossa; *insertion,* into the lesser tuberosity of the humerus; *action,* rotates the head of the humerus inward; *nerves,* upper and lower subscapular.

SUPRASPINATUS.—*Origin,* from inner two-thirds of supraspinous fossa; *insertion,* into the uppermost facet of the great tuberosity of the humerus; *action,* assists in raising the arm and fixing the head of the humerus; *nerve,* the suprascapular.

INFRASPINATUS.—*Origin,* from the inner two-thirds of the infraspinous fossa; *insertion,* into the middle facet of the great tuberosity; *action,* rotates the head of the humerus outward; *nerve,* supra-scapular.

TERES MINOR.—*Origin,* posterior surface of the upper two-thirds of the axillary border of the scapula; *insertion,* into the lowest facet of the great tuberosity; *action,* rotates the head of the humerus outward; *nerve,* the circumflex.

TERES MAJOR.—*Origin,* posterior surface of the inferior angle of the scapula; *insertion,* into the posterior bicipital ridge of the humerus; *action,* draws the humerus backward and downward, assisting the latissimus dorsi; *nerve,* the lower subscapular.

HUMERAL REGION.

CORACO-BRACHIALIS.—*Origin,* from apex of the coracoid process of the scapula; *insertion,* into the inner side of the middle of the shaft of the humerus, between the origin of the

brachialis anticus and short humeral head of the triceps; *action,* draws the humerus inward and forward; *nerves,* the musculo-cutaneous and a branch of the musculo-spiral.

BICEPS (FLEXOR CUBITI).—*Origin,* by two heads; short head from the apex of the coracoid process, along with the coraco-brachialis; the long (glenoid) head from the upper margin of the glenoid cavity of the scapula; *insertion,* into the posterior

FIG. 97.

Muscles of shoulder and arm: 4, subscapularis; 5, teres major; 6, coraco-brachialis; 7, biceps.

FIG. 98.

Triceps muscle: 1, external head; 2, scapular head; 4, insertion.

part of the tuberosity of the radius; *action,* flexes the forearm; *nerve,* the musculo-cutaneous.

BRACHIALIS ANTICUS.—*Origin,* inner and outer surfaces of the shaft of the humerus, embracing the insertion of the deltoid; *insertion,* into the anterior surface of the coronoid process of the ulna; *action,* flexes the forearm; *nerve,* the musculo-cutaneous.

TRICEPS (EXTENSOR CUBITI).—*Origin,* by three heads—middle, or scapular head, below the glenoid cavity of the scapula; external head, from the posterior aspect of the shaft of the

humerus, between the upper part of the musculo-spiral groove and the insertion of the teres minor, and from the external intermuscular septum; the internal head, from the posterior aspect of the shaft of the humerus, below the insertion of the teres major, and below the groove for the musculo-spiral nerve; *insertion,* by a common head, into the posterior part of the under surface of the olecranon process of the ulna; *action,* extends the forearm; *nerve,* the musculo-spiral.

SUBANCONEUS.—*Origin,* from the posterior surface of the humerus, above the olecranon fossa; *insertion,* into the posterior ligament of the elbow-joint; *action,* draws up the posterior ligament of the elbow-joint during extension of the forearm; *nerve,* the musculo-spiral.

MUSCLES OF THE FOREARM.

Anterior Superficial Layer.

PRONATOR RADII TERES.—*Origin,* by two heads—the smaller from the coronoid process of the ulna, the larger from the humerus, above the internal condyle, and from the common tendon of this group of muscles, and intermuscular septum; *insertion,* into the outer aspect of the shaft of the radius; *action,* pronates the hand; *nerve,* the median.

FLEXOR CARPI RADIALIS.—*Origin,* by the common tendon from the inner condyle, and from the intermuscular septum between it and the pronator teres; *insertion,* into the base of the metacarpal bone of the index finger; *action,* flexes the wrist; *nerve,* the median.

PALMARIS LONGUS.—*Origin,* from the inner condyle of the humerus by the common tendon and the intermuscular septum and the deep fascia; *insertion,* into the annular ligament, spreading out in the palmar fascia; *action,* renders tense the palmar fascia; *nerve,* the median.

FLEXOR CARPI ULNARIS.—*Origin,* by two heads—one by the common tendon from the inner condyle of the humerus, the other from the inner margin of the olecranon, the intermuscular septum, between the ulna and the flexor sublimis digitorum, and from the upper two-thirds of the posterior aspect of the ulna; *insertion,* pisiform bone; *action,* flexes the wrist; *nerve,* the ulnar.

FLEXOR SUBLIMIS DIGITORUM (PERFORATUS).—*Origin,* by three heads—one from the coronoid process of the ulna, above the pronator radii teres, another from the common tendon from the internal condyle of the humerus, and the third from the

oblique line of the radius, from the insertion of the pronator radii teres, to the tubercle; each tendon divides at the base of the first phalanges to allow the passage of the tendon of the flexor profundus digitorum; *insertion,* into the lateral margins of the second phalanges by four tendons; *action,* flexes the second phalanges; *nerve,* median.

FIG. 99.

Muscles of forearm: 1, biceps; 2, brachialis anticus; 3, triceps; 4, supinator longus; 5, extensor carpi radialis longior; 6, extensor carpi radialis brevior; 8, extensor communis digitorum; 12, extensor carpi ulnaris; 13, 14, extensors of thumb.

Anterior Deep Layer.

FLEXOR PROFUNDUS DIGITORUM (PERFORANS).—*Origin,* from the inner side of the coronoid process, and from the upper two-thirds of the front and inner aspect of the shaft of the ulna, between the brachialis anticus above and the pronator quadratus below; *insertion,* by four tendons into the bases of the last phalanges, perforating the tendons of the flexor sublimis; *action,* flexes the phalanges; *nerves,* the anterior interosseous and the ulnar.

FLEXOR LONGUS POLLICIS.—*Origin,* from the upper two-thirds of the shaft of the radius and from the interosseous membrane; *insertion,* into the base of the last phalanx of the thumb; *action,* flexes the phalanges; *nerve,* the anterior interosseous.

PRONATOR QUADRATUS. — *Origin,* anterior border of the ulna and from the oblique line of the lower fourth of the anterior aspect of the ulna; *insertion,* into the lower fourth of the front and outer border of the shaft of the radius; *action,* pronates the hand; *nerve,* anterior interosseous.

Radial Region.

SUPINATOR LONGUS.—*Origin,* from the upper two-thirds of the external condyloid ridge of the humerus and the external intermuscular septum; *insertion,* into the base of the styloid process of the radius; *action,* supinates the hand; *nerve,* musculo-spiral.

EXTENSOR CARPI RADIALIS LONGIOR.—*Origin,* from the lower third of the external condyloid ridge of the humerus, from the common tendon of the extensor muscles of the forearm from the external condyle, and the intermuscular septum; *insertion,* into the radial side of the base of the metacarpal bone of the index finger; *action,* extends the wrist; *nerve,* musculo-spiral.

EXTENSOR CARPI RADIALIS BREVIOR.—*Origin,* from the common tendon, from the external condyle of the humerus, the external lateral ligament, and the intermuscular septum; *insertion,* into the base of the metacarpal bone of the middle finger on its radial side; *action,* extends the wrist; *nerve,* posterior interosseous.

Posterior Superficial Layer.

EXTENSOR COMMUNIS DIGITORUM.—*Origin,* from the external condyle of the humerus, the deep fascia, and the intermuscular septa; *insertion,* by four tendons into the second and third phalanges of all the fingers (at the first phalanx they receive the insertion of the lumbricales and interossei); *action,* extends the fingers; *nerve,* posterior interosseous.

EXTENSOR MINIMI DIGITI.—*Origin,* from the common tendon from the external condyle and the intermuscular septum; *insertion,* into the second and third phalanges of the little finger; *action,* extends the little finger; *nerve,* posterior interosseous.

EXTENSOR CARPI ULNARIS.—*Origin,* from the middle third of the posterior border of the ulna, from the common tendon from the external condyle of the humerus, and from the fascia of the forearm; *insertion,* into the base of the metacarpal bone of the little finger, on the ulnar side; *action,* extends the wrist; *nerve,* posterior interosseous.

ANCONEUS.—*Origin,* from the outer condyle of the humerus; *insertion,* into the upper fourth of the posterior aspect of the shaft of the ulna and the side of the olecranon; *action,* extends the forearm; *nerve,* musculo-spiral.

Posterior Deep Layer.

SUPINATOR BREVIS.—*Origin,* from the external lateral ligament of the elbow-joint, from the external condyle of the humerus, from the ulna below the lesser sigmoid cavity, and from the orbicular ligament of the radius and the external lateral ligament of the elbow-joint; *insertion,* into the neck, bicipital tuberosity and oblique line of radius; the posterior interosseous nerve pierces this muscle; *action,* supinates the hand; *nerve,* posterior interosseous.

EXTENSOR OSSIS METACARPI POLLICIS.—*Origin,* middle third of posterior surface of radius, posterior surface of lower three-fourths of shaft of ulna, and interosseous ligament; *insertion,* into base of metacarpal of thumb; *action,* extends metacarpal of thumb; *nerve,* posterior interosseous.

EXTENSOR PRIMI INTERNODII (LONGUS) POLLICIS.—*Origin,* from the interosseous membrane and from the posterior aspect of the shaft of the radius; *insertion,* into the base of the first phalanx of the thumb; *action,* extends the thumb; *nerve,* posterior interosseous.

EXTENSOR SECUNDI INTERNODII (BREVIS) POLLICIS.—*Origin,* from the posterior aspect of the shaft of the ulna and from the interosseous membrane; *insertion,* into the last phalanx of the base of the thumb; *action,* extends the thumb; *nerve,* posterior interosseous.

EXTENSOR INDICIS.—*Origin,* from the posterior aspect of the ulna and from the interosseous membrane; *insertion,* into the second and third phalanges of the index finger, along with the tendon of the extensor communis; *action,* extends the index finger; *nerve,* posterior interosseous.

MUSCLES OF THE HAND.

These are divided into three groups—the radial region, the ulnar region, and the palmar region.

Radial Region.

ABDUCTOR POLLICIS.—*Origin,* from the annular ligament and ridge of the trapezium; *insertion,* into base of the first phalanx of the thumb on its radial side; *action,* abducts the thumb from the median line; *nerve,* median.

OPPONENS POLLICIS.—*Origin,* from annular ligament and palmar surface of the trapezium; *insertion,* into metacarpal bone of the thumb throughout the whole length of its radial side; *action,* flexes the first metacarpal bone; *nerve,* median.

FLEXOR BREVIS POLLICIS.—This muscle consists of two portions, divided by tendon of flexor longus pollicis; *origin,* superficial portion from outer two-thirds of annular ligament and trapezium, deeper portion (by some called adductor obliquus pollicis) from sheath of flexor carpi radialis, the trapezoid, os magnum, and base of first, second, and third metacarpal bones; *insertion,* into either side of base of first phalanx of thumb, the inner portion joining the adductor and the outer portion the abductor; each tendon has a sesamoid bone developed in it; *action,* adducts thumb toward median line; *nerves,* ulnar and median.

ADDUCTOR POLLICIS (ADDUCTOR TRANSVERSUS POLLICIS).—*Origin,* from lower two-thirds palmar surface of middle metacarpal bone; *insertion,* into ulnar side of base of first thumb phalanx and internal sesamoid bone; *action,* adducts thumb; *nerve,* ulnar.

Ulnar Region.

PALMARIS BREVIS.—*Origin,* from palmar fascia and annular ligament; *insertion,* into skin of palm of hand; *action,* wrinkles skin of hand; *nerve,* ulnar.

ABDUCTOR MINIMI DIGITI.—*Origin,* from pisiform bone and from tendon of flexor carpi ulnaris; *insertion,* into base of first phalanx of little finger on its ulnar side; *action,* abducts little finger from median line; *nerve,* ulnar.

FLEXOR BREVIS MINIMI DIGITI.—*Origin,* from annular ligament and tip of unciform process of unciform bone; *insertion,* into the first phalanx of little finger; *action,* flexes little finger; *nerve,* ulnar.

OPPONENS MINIMI DIGITI.—*Origin,* from annular ligament and from unciform process of unciform bone; *insertion,* into ulnar border of whole length of metacarpal bone of little finger; *action,* flexes little finger; *nerve,* ulnar.

Palmar Region.

LUMBRICALES.—*Origin,* by four fleshy tendons from the tendons of the deep flexors—the first and second from the palmar surface and radial side of the tendons of the index and middle fingers, the third from the adjoining sides of the tendons of the middle and ring fingers, and the fourth from the adjoining sides of the tendons of the ring and little fingers; *insertion,* on dorsal aspect of each finger into the expansion of the extensor communis digitorum; *action,* abduct the fingers to either side of the median line; *nerves,* ulnar and median.

INTEROSSEI MUSCLES consist of two groups, the dorsal and palmar.

DORSAL INTEROSSEI.—*Origin,* from two heads from the adjacent sides of the metacarpal bones, four in number; *insertion,* the first into the radial side of the base of the first phalanx of the index finger, the second into the radial side of the middle finger, the third into the ulnar side of the middle finger, and the fourth into the ulnar side of the ring finger, the middle finger having two, one on either side; *action,* abduct the fingers from the median line; *nerve,* ulnar.

PALMAR INTEROSSEI.—Three in number. *Origin,* the first from the entire length of the metacarpal bone of the index finger on its ulnar side, the second from the ring finger on its radial side, and the third from the little finger on its radial side; *insertion,* into the base of the first phalanx and into the expansion of the extensor communis tendon of the same finger from which they arise; *action,* adduct the fingers toward the median line; *nerve,* ulnar.

MUSCLES OF THE LOWER EXTREMITY.

ILIAC REGION.

PSOAS MAGNUS.—*Origin,* from the sides and anterior surfaces of the transverse processes and bodies of the last dorsal and all the lumbar vertebræ and the intervertebral substances between them; *insertion,* into the lesser trochanter of the femur, uniting with the tendon of the iliacus; this muscle is in relation behind with the capsular ligament of the hip, being separated from it by a synovial bursa; *action,* flexes and rotates the femur inward, and also flexes the trunk and pelvis on the thigh; *nerves,* anterior branches of the lumbar nerves.

PSOAS PARVUS.—*Origin,* from the lateral surfaces of the bodies of the last dorsal and first lumbar vertebræ and from the intervertebral substances between them; *insertion,* into the iliopectineal eminence, joining the iliac fascia; *action,* assists the psoas magnus and renders tense the iliac fascia; *nerves,* anterior branches of the lumbar.

ILIACUS.—*Origin,* from the base of the sacrum and the iliolumbar ligament behind, from the iliac fossa and inner margin of the crest of the ilium and the anterior superior and anterior inferior spinous processes of the ilium; *insertion,* into the oblique or intertrochanteric line of the femur to the outer side of the insertion of the psoas; *action,* flexes and rotates the femur inward and flexes the trunk and pelvis on the thigh; *nerves,* anterior crural and the anterior branches of the lumbar.

FEMORAL AND GLUTEAL REGION.

TENSOR VAGINÆ FEMORIS.—*Origin,* from the anterior superior spinous process between the sartorius and the gluteus medius, and from the fore part of the outer lip of the crest of the ilium; *insertion,* into the fascia lata, about the upper fourth of the outer side of the thigh; *action,* renders tense the fascia lata; *nerve,* superior gluteal.

SARTORIUS.—*Origin,* from the anterior superior spinous process of the ilium and the upper part of the notch below; *insertion,* into the inner and upper part of the shaft of the tibia; *action,* flexes the leg upon the thigh and the thigh upon the pelvis; *nerve,* branches of the anterior crural.

QUADRICEPS EXTENSOR.—This extensive muscle covers the front and sides of the femur and consists of four portions—the rectus femoris, the vastus externus, the vastus internus, and the crureus.

RECTUS FEMORIS.—*Origin,* by two heads—one, the long head, from the groove above the brim of the acetabulum; the other, the short head, from the anterior inferior spinous process of the ilium; insertion, by the common tendon into the patella; *action,* extends the leg upon the thigh; *nerves,* branches of the anterior crural.

VASTUS EXTERNUS.—Forms the greater part of the quadriceps extensor. *Origin,* by an extensive aponeurosis extending from the tubercle of the femur along the anterior border of the great trochanter and the whole length of the outer lip of the linea aspera; *insertion,* into the outer portion of the patella, joining the common tendon; *action,* extends the leg on the thigh; *nerves,* branches of the anterior crural.

VASTUS INTERNUS AND CRUREUS.—*Origin,* by a tendinous aponeurosis extending from the neck of the femur throughout the whole length of the inner lip of the linea aspera; *insertion,* into the common tendon, together with the rectus femoris and the vastus externus; *action,* extends the leg on the thigh; *nerves,* branches of the anterior crural.

SUBCRUREUS.—*Origin,* from the anterior aspect of the lower part of the shaft of the femur; *insertion,* into the synovial sac behind the patella.

GRACILIS.—*Origin,* from the inner margin of the ramus of the ischium and the pubes; *insertion,* into the inner aspect of the shaft of the tibia, below the tuberosity; *action,* flexes the leg and draws it inward, assisting the sartorius; *nerve,* the obturator.

PECTINEUS.—*Origin,* from the tendinous prolongation of Gimbernat's ligament and the linea ilio-pectinea; *insertion,* into the rough line leading to the linea aspera from the lesser trochanter; *action,* adducts the thigh; *nerves,* obturator, the accessory obturator, and branches of the anterior crural.

ADDUCTOR LONGUS.—*Origin,* from the front of the os pubis below the crest; *insertion,* into the middle third of the linea aspera, between the adductor magnus and the vastus internus; *action,* adducts the thigh; *nerve,* obturator.

ADDUCTOR BREVIS.—*Origin,* from the outer aspect of the descending ramus of the pubes, between obturator externus and the gracilis; *insertion,* into the upper part of the linea aspera; *action,* adducts the thigh; *nerves,* branches of the obturator.

ADDUCTOR MAGNUS.—*Origin,* from the tuberosity of the ischium, the ascending ramus of the ischium, and from the descending ramus of the pubes; *insertion,* into the rough line leading to the linea aspera from the great trochanter to the inner side of the gluteus maximus and into the adductor tubercle above the inner condyle of the femur (*vide* page 64); *action,* adducts the thigh; *nerves,* the obturator and a branch from the great sciatic.

GLUTEUS MAXIMUS.—*Origin,* from the superior curved line of the ilium, the posterior aspect of the last segment of the sacrum, the border of the coccyx, and the surface of the great sacro-sciatic and posterior sacro-iliac ligaments; *insertion,* into the rough line leading to the linea aspera from the great trochanter, between the adductor magnus and the vastus externus, and into the fascia lata; *action,* it is a tensor of the fascia lata, and an external rotator and extensor of the thigh; *nerves,* the inferior gluteal and a branch from the sacral plexus.

GLUTEUS MEDIUS.—*Origin,* from the outer lip of the crest and the outer aspect of the ilium, between the middle and superior curved lines, and from the gluteal aponeurosis; *insertion,* into the oblique line on the outer surface of the great trochanter; *action,* rotates the thigh outward; *nerve,* from the superior gluteal.

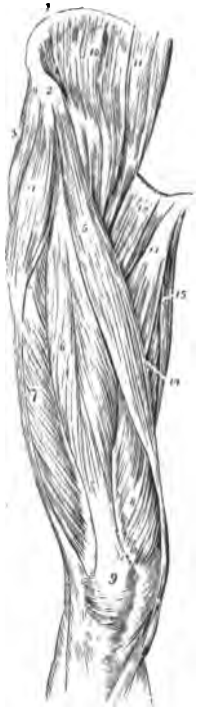


FIG. 100.

Anterior femoral region: 4, tensor vaginæ femoris; 5, sartorius; 6, rectus; 7, vastus externus; 8, vastus internus; 10, iliacus; 11, psoas; 12, pectineus; 13, adductor longus; 14, adductor magnus; 15, gracilis.

GLUTEUS MINIMUS.—*Origin,* from the border of the great sacro-sciatic notch and between the inferior and middle curved lines of the outer aspect of the ilium; *insertion,* into a depression on the front border of the great trochanter; *action,* rotates the thigh inward; *nerve,* superior gluteal.

PYRIFORMIS.—Origin, from the anterior surface of the sacrum, between the first to the fourth anterior sacral foramen, and from the margin of the great sacro-sciatic foramen, and from the anterior aspect of the great sacro-sciatic ligament; *insertion,* into the upper border of the great trochanter, with the tendon of the obturator internus; *action,* rotates femur outward; *nerve,* obturator.

FIG. 101.

Posterior femoral region: 1, gluteus medius; 2, gluteus maximus; 3, vastus externus; 4, biceps; 6, semi-tendinosis; 7, semi-membranosis; 8, gracilis.

OBTURATOR INTERNUS. — *Origin,* from the inner side of the obturator foramen and the internal surface of obturator membrane and the anterior and external wall of the pelvis it passes out of the pelvis through the lesser sacro-sciatic notch and receives the tendons of the gemelli muscles; *insertion,* into the upper border of the great trochanter in front of the pyriformis; *action,* rotates the thigh outward; *nerves,* branches from the sacral plexus.

GEMELLI consist of two muscles —gemellus superior and gemellus inferior.

GEMELLUS SUPERIOR. — *Origin,* from the outer aspect of the spine of the ischium; *insertion,* into the tendon of the obturator internus.

GEMELLUS INFERIOR. — *Origin,* from the outer border of tuberosity of the ischium; *insertion,* into the lower portion of the tendon of the obturator internus; *action,* rotates the thigh outward; *nerves,* branches of the sacral plexus.

QUADRATUS FEMORIS. — *Origin,* from the external border of the tuberosity of the ischium; *insertion,* into the upper part of the linea quadrati, on the posterior aspect of the trochanter major; *action,* rotates the thigh outward; *nerves,* branches of the sacral plexus.

OBTURATOR EXTERNUS.—*Origin,* from the inner two-thirds of the anterior aspect of the obturator membrane and the tendinous arch covering the canal for the obturator vessels and nerves, and the descending ramus of the pubis and the ascending ramus

of the ischium; *insertion,* into the digital fossa of the femur; *action,* rotates the thigh outward; *nerve,* the obturator.

BICEPS.—*Origin,* arises by two heads—the long head, from the lower and inner facet of the tuberosity of the ischium by a common tendon to the long head of the semi-tendinosus; the short head, from the outer lip of the linea aspera, between the vastus externus and the adductor magnus; *insertion,* outer side of head of fibula, by two portions, on either side of the external lateral ligament of the knee-joint, sending a band forward to the outer tuberosity of the tibia. This tendon forms the outer hamstring; *action,* flexes the leg upon the thigh; *nerve,* the great sciatic.

SEMI-TENDINOSUS.—*Origin,* from a common tendon, together with the long head of the biceps, from the tuberosity of the ischium; *insertion,* into the inner and upper part of the shaft of the tibia; *action,* rotates the leg inward; *nerve,* the great sciatic.

SEMI-MEMBRANOSUS. — *Origin,* from the outer and upper facet of the tuberosity of the ischium to the outer side and above the origin of the semi-membranosus and the biceps; *insertion,* into the posterior inner aspect of the inner tuberosity of the tibia, under the internal lateral ligament by three portions—the internal portion into the inner side of the internal tuberosity, the posterior portion into the posterior part of the outer condyle of the femur, forming the principal part of the posterior ligament of the knee-joint, and middle portion into the posterior aspect of the inner tuberosity; *action,* flexes the leg upon the thigh; *nerve,* the great sciatic.

These two tendons (semi-membranosus and semi-tendinosus), together with the gracilis and sartorius, form the inner hamstring.

MUSCLES OF THE LEG.

Anterior Set.

TIBIALIS ANTICUS.—*Origin,* from the upper and outer two-thirds of the shaft of the tibia, the interosseous membrane, and the intermuscular septum between it and the extensor longus digitorum; *insertion,* into the lower and inner aspect of the internal cuneiform bone and base of the first metatarsal bone; *action,* flexes the foot; *nerve,* the anterior tibial.

EXTENSOR PROPRIUS POLLICIS.—*Origin,* from the anterior aspect of the fibula and the interosseous membrane and the intermuscular septum between it and the extensor longus digitorum; *insertion,* into the base of the last phalanx of the great toe; *action,* extends the great toe; *nerve,* the anterior tibial.

EXTENSOR LONGUS DIGITORUM.—*Origin,* from the upper two-thirds of the anterior aspect of the shaft of the fibula and the outer tuberosity of the tibia, from the deep fascia of the interosseous membrane and the intermuscular septum, between it and the perinei on the outer and the tibialis anticus on the inner side; *insertion,* by three tendons into the bases of the first and

FIG. 102.

Anterior muscles of leg: 3, tibialis anticus; 4, extensor longus digitorum; 5, extensor proprius pollicis; 6, peroneus tertius; 7, peroneus longus; 8, peroneus brevis.

FIG. 103.

Posterior muscles of leg: 4, popliteus; 5, gastrocnemius; 6, tendo Achillis; 8, tendons of peroneus longus and brevis; 9, tibialis posticus and flexors.

second phalanges of the four lesser toes, the innermost tendon dividing into two; each tendon (except the fourth) is joined opposite the metatarso-phalangeal joint by the tendon of the extensor brevis digitorum, and receives an expansion from the lumbricales and interossei; at the first interphalangeal articulation the tendons divide into three slips—the middle one for inser-

tion into the second phalanges, and the other two uniting to be inserted into the bases of the third; *action,* extends the phalanges and, continuing, flexes the foot upon the leg; *nerve,* the anterior tibial.

PERONEUS TERTIUS.—*Origin,* from the lower front part of the fibula on its outer side, from the interosseous membrane, and the intermuscular septum between it and the peroneus brevis; *insertion,* into the metatarsal bone of the little toe; *action,* flexes the tarsus upon the leg; *nerve,* the anterior tibial.

Posterior Superficial Set.

GASTROCNEMIUS.—*Origin,* from the upper and back part of the external and internal condyles of the femur on either side, above the origin of the popliteus, and from the supracondyloid ridges; *insertion,* by joining with the tendon of the soleus to form the tendo Achillis; *action,* extends the foot; *nerve,* from the internal popliteal.

SOLEUS.—*Origin,* from the oblique line of the tibia, from the middle third of the internal border, and from the posterior surface of the head of the fibula; *insertion,* by joining with the tendon of the gastrocnemius to form the tendo Achillis; *action,* extends the foot; *nerve,* the internal popliteal.

TENDO ACHILLIS.—*Origin,* from the union of the gastrocnemius and soleus; is the largest and strongest tendon in the body; it is inserted into the inferior surface of the posterior tuberosity of the os calcis, having a synovial bursa between it and the bone.

PLANTARIS.—*Origin,* from the posterior ligament of the knee-joint and the lower portion of the outer division of the linea aspera; *insertion,* into the posterior part of the os calcis to the inner side of the tendo Achillis; *action,* the rudiment of a muscle intended to render tense the plantar fascia; *nerve,* the internal popliteal.

Posterior Deep Set.

POPLITEUS.—*Origin,* from the outer side of the external condyle, from the posterior ligament of the knee-joint; *insertion,* above the oblique line on the posterior aspect of the shaft of the tibia; *action,* assists in flexing the leg; *nerve,* the internal popliteal.

FLEXOR LONGUS POLLICIS.—*Origin,* from the lower two-thirds of the internal surface of the fibula, from the lower part of the interosseous membrane, fascia covering tibialis posticus,

and from the intermuscular septum; it passes behind the internal malleolus; *insertion,* into the base of the last phalanx of the great toe; *nerve,* posterior tibial.

Flexor Longus Digitorum (Perforans).—*Origin,* from the posterior aspect of the tibia, below the oblique line; it passes behind the internal malleolus; *insertion,* into the bases of the last phalanges of the four lesser toes, passing through the division in the tendons of the flexor brevis digitorum; *action,* flexes the phalanges and, continuing, extends the foot on the leg; *nerve,* the posterior tibial.

Tibialis Posticus.—*Origin,* from the posterior aspect of the shaft of the tibia, and from the upper two-thirds of the shaft of the fibula, and from the whole length of the interosseous membrane and the intermuscular septa on either side of it; it passes behind the inner malleolus; *insertion,* into the internal cuneiform bone and the tuberosity of the scaphoid; it contains a sesamoid bone in its tendon; *action,* extends the tarsus upon the leg; *nerve,* the posterior tibial.

Fibular Region.

Peroneus Longus.—*Origin,* from the upper two-thirds of the shaft of the fibula, the head of the fibula, the intermuscular septa, and the deep fascia; it passes behind the outer malleolus along with the peroneus brevis; *insertion,* into the base of the metatarsal bone of the great toe; this tendon changes its course twice, first at the external malleolus, second at the cuboid bone, and usually has a sesamoid bone developed in its tendon; *action,* extends and everts the foot upon the leg; *nerve,* musculo-cutaneous branch of the external popliteal.

Peroneus Brevis.—*Origin,* from the outer and middle third of the fibula and the intermuscular septa on either side; *insertion,* into the upper surface of the base of the metatarsal bone of the little toe; *action,* extends the foot upon the leg; *nerve,* musculo-cutaneous branch of the external popliteal.

MUSCLES OF THE FOOT.

Dorsal Region.

Extensor Brevis Digitorum.—*Origin,* from the external calcaneo-astragaloid ligament, from the annular ligament, and from the outer side of the os calcis; *insertion,* by four tendons—the first one into the first phalanx of the great toe, the other three into the long extensor tendons of the second, third, and fourth

toes on their outer sides; *action,* extends the phalanges of the four inner toes and the first phalanx of the great toe; *nerve,* the anterior tibial.

Plantar Region.

The muscles of this region are divided into four sets.

First Set.

ABDUCTOR POLLICIS.—*Origin,* from the internal annular ligament, from the inner tubercle of the os calcis, from the intermuscular septum on its outer side; plantar fascia; *insertion,* into the base of the first phalanx of the great toe on its inner side; *action,* abducts the great toe; *nerve,* branch of the internal plantar.

FLEXOR BREVIS DIGITORUM (PERFORATUS).—*Origin,* from the inner tubercle of the os calcis, from the plantar fascia and the intermuscular septa between it and the muscles on either side; *insertion,* into the second phalanges by a process on either side, allowing the passage of the tendon of the flexor longus digitorum; *action,* flexes first lesser toes; *nerve,* from the internal plantar.

ABDUCTOR MINIMI DIGITI.—*Origin,* from the plantar fascia, from the os calcis in front of the tubercle, and from the intermuscular septum on its inner side; *insertion,* into the first phalanx of the little toe on its outer side; *action,* abducts little toe; *nerve,* external plantar.

Second Set.

FLEXOR ACCESSORIUS.—*Origin,* by two heads, one from the os calcis in front of the outer tubercle, the other from the inner surface of the os calcis and the calcaneo-scaphoid ligament; *insertion,* by a common tendon into the tendon of the flexor longus digitorum; *action,* accessory to the long flexor; *nerve,* external plantar.

LUMBRICALES.—Four small muscles. *Origin,* from the tendons of the flexor longus digitorum, after their division, each one arising from two tendons; *insertion,* into the base of the first phalanx of the same toe and the tendinous expansion of the extensor longus digitorum; *nerves,* the external plantar nerve supplies the two external, the internal plantar nerve the two internal, muscles.

Third Set.

FLEXOR BREVIS POLLICIS.—*Origin,* from the external cuneiform bone, and the internal border of the cuboid bone, and the tendinous expansion of the tibialis posticus; *insertion,* into the first phalanx of the great toe on either side; *action,* flexes first phalanx of great toe; *nerves,* the internal plantar and sometimes a branch from the external plantar.

ADDUCTOR POLLICIS.—*Origin,* from the bases of the second, third, and fourth metatarsal bones and from the sheath of the tendon of the peroneus longus; *insertion,* into the base of the first phalanx of the great toe on the outer side; *nerve,* external plantar.

FLEXOR BREVIS MINIMI DIGITI.—*Origin,* from the sheath of the peroneus longus and the base of the metatarsal bone of the little toe; *insertion,* into the outer side of the base of the little toe; *nerve,* external plantar.

TRANSVERSUS PEDIS.—*Origin,* from the inferior surface of the head of the fifth metatarsal bone, from the transverse metatarsal ligament; *insertion,* into the first phalanx of the great toe, on its outer side; *action,* adducts the great toe; *nerve,* the external plantar.

Fourth Set.

DORSAL INTEROSSEI.—Four in number. *Origin,* by two heads from the adjoining bases of the metatarsal bones; *insertion,* into the bases of the first phalanges of the second, third, and fourth toes, the second having two, one on either side, and the third and fourth on their outer side; *action,* abduct the toes from the middle line of the second toe; *nerve,* external plantar.

PLANTAR INTEROSSEI.—Three in number. *Origin,* from the bases of inner side of the third, fourth, and fifth metatarsal bones; *insertion,* into the bases of the first phalanges on the same side; *action,* adduct the toes toward the middle line of the second toe; *nerve,* the external plantar.

THE FASCIAS.

The fascias are strong, fibrous (fibro-areolar) investments protecting and binding together the muscles, and in places forming ligaments and intermuscular septa. They consist for the most part of two layers, a superficial and a deep.

FASCIAS OF THE HEAD AND FACE.—The *superficial fascia* of the *head* and *face* is everywhere intimately connected to the skin, except over the temporal region, where it forms a distinct lamina, inclosing the superficial temporal vessels and auricular muscles.

The *deep temporal fascia* is a dense, fibrous membrane, attached to the margins of the temporal fossa and zygoma, and from which in part the temporal muscle arises.

FASCIAS OF THE NECK.—The *superficial fascia* is continuous below with that covering the pectoral muscles and deltoid, and blends above with the superficial facial muscles and fascia.

The *deep fascia* adheres below to the clavicle and sternum, and is continuous with the thoracic fascia. As it ascends the neck it ensheathes the great vessels of the neck, sends processes to the larynx, trachea, pharynx, and œsophagus, and above ensheathes the submaxillary and parotid glands, and forms the stylo-maxillary ligament.

FASCIAS OF THE TRUNK.—The *superficial fascia* may consist of two or more layers in places. It is continuous above with the fascias of the neck and upper extremity, and below with the thigh. Over the pectoral region the mammary glands are inclosed between its layers; below the level of the umbilicus it again divides into two layers, the superficial of which is continuous with the superficial layer of the superficial fascia in the thigh, while the deep layer is attached to the crest of the ilium and Poupart's ligament.

The *deep fascia* forms intermuscular septa and aponeuroses.

THE LUMBAR FASCIA divides into three layers, inclosing the quadratus lumborum, multifidus spinæ, and erector spinæ muscles, and giving attachment to the internal oblique and transversalis muscles. Its anterior and middle layers are attached to the transverse processes, and its posterior layer to the spinous processes. Above its anterior layer is attached to the lower border of the last rib, forming the *ligamentum arcuatum externum.* (The ligamentum arcuatum internum extends from the body of the first or second lumbar vertebra to the transverse process, inclosing the psoas magnus muscle.)

ABDOMINAL AND PELVIC FASCIA.—The transversalis fascia is a thin aponeurosis between the peritoneum and transversalis muscle. It is attached below to the pubes, pectineal line, Poupart's ligament, and the femoral vessels, and becomes continuous with the iliac and pelvic fascia. The pelvic fascia lines the pelvic cavity throughout, attached to the symphysis pubis, margin of obturator foramen, and the sacrum, and becomes continuous with the iliac and transversalis fascias. Below it forms the *arcus tendinæ,* for the origin of muscles and the division into the recto-vesical and obturator fascias (*vide* Perineum).

THE ILIAC FASCIA is a thin, fibrous membrane investing the psoas and iliacus muscles. Above it is attached to the ligamentum arcuatum internum, laterally with the bodies of the verte-

bræ and sacrum, and below it is attached to Poupart's ligament, the femoral vessels, pectineal eminence, and the capsule of the hip-joint.

UPPER EXTREMITY.—The *superficial fascia* is a thin membrane, inclosing the parts throughout, and adherent to the deep fascia beneath.

The *deep fascia* is very dense and strong. It gives off numerous intermuscular septa, and is attached to the olecranon and back part of ulna, and becomes continuous below with the anterior and posterior annular ligaments of the wrist-joint, both of which it forms.

The *anterior annular ligament* is attached to the ridge of the trapezium, the tuberosity of the scaphoid, the unciform process of the unciform, and the pisiform bone, forming a strong, fibrous arch, under which the flexor tendons of the fingers pass.

The *posterior annular ligament* is attached to the radius, ulna, cuneiform, and pisiform bones, and the palmar fascia, forming a fibrous arch for the passage of the extensors of the fingers.

The *palmar fascia* is an exceedingly dense, triangular mass of adipose and fibrous tissue, attached behind to the anterior annular ligament, and in front divides into four fasciculi, each of which subdivides into two, inserted into the lateral ligaments of the metacarpo-phalangeal articulations. These digitations allow the passage of the flexor digitorum tendons, the digital vessels, and nerves. It is attached above to the skin, and laterally gives off vertical septa, which separate the middle from the lateral groups of palmar muscles.

FASCIAS OF THE LOWER EXTREMITY.

The *superficial fascia* resembles that in other localities, except that, in the front of the thigh, it consists of two or more layers between which are found the superficial vessels and nerves and lymphatic glands. The under layer is attached to the margins of the saphenous opening, where it is perforated by numerous lymphatic vessels and blood-vessels; hence its name, *cribriform fascia.*

The *deep fascia* of the thigh, or *fascia lata,* is a dense fibrous aponeurosis attached to the pubes, Poupart's ligament, crest of the ilium, sacrum, and coccyx, inclosing the gluteus maximus and tensor vaginæ femoris between its layers, attached to the linea aspera, and below to all the bony points about the knee-joint, being attached to the head of the fibula and tuberosities of the tibia by the *ilio-tibial band.*

The *saphenous opening* is a large opening in the fascia lata at its upper and inner part closed by the cribriform fascia. Through it pass the internal or long saphenous vein, the superficial epigastric and external pudic arteries, and lymphatics. It is formed by the *iliac* and *pubic portions* of the *fascia lata.* The iliac portion becomes continuous at the pectineal line with Gimbernat's ligament, and its free border forms the *falciform border* (*vide* Femoral Hernia).

The pubic portion is continuous behind the femoral vessels with the femoral sheath and the iliac and psoas fascia. At the lower border of the saphenous opening it is continuous with the iliac portion of the fascia lata.

The *deep fascia of the leg* is attached above to the bony points about the knee, continuous with the fascia lata, invests the leg completely, except the inner surface of the tibia, sends in a *deep transverse fascia* between the superficial and deep muscles on the posterior aspect of the leg, and below becomes continuous with the annular ligament of the ankle-joint.

The *annular ligament* of the *ankle-joint* consists of three portions—the *internal, external,* and *anterior.* It is attached to the bony points about the ankle-joint, the external and internal malleoli, surfaces of the os calcis, and allows the passage of the muscles to the foot.

The *dorsal aponeurosis* of the *foot* covers the back of the foot, uniting with the plantar fascia at the sides, and terminating anteriorly at the heads of the metatarsal bones.

The *plantar aponeurosis* consists of three portions, a central and two lateral portions.

The *middle* commences at the inner tubercle of the os calcis and proceeds, gradually becoming broader, to the heads of the metatarsal bones, where it divides into four branches, each of which nearly surrounds the corresponding flexor tendon to which it gives passage, and is inserted into the edges of the dorsal expansion of the first phalanges.

The *inner portion* arises from the internal annular ligament, covers the abductor pollicis muscle, and joins the dorsal aponeurosis internally and the internal septum externally.

The *outer portion,* much stronger, arises from the os calcis, covers the abductor minimi digiti muscle, and joins the external plantar septum internally and dorsal aponeurosis externally, and is firmly attached to the base of the fifth metatarsal bone.

Numerous septa pass from the upper surface of the plantar fascia between the plantar muscles and tendons to be inserted into the metatarsal and tarsal bones.

THE HEART AND VASCULAR SYSTEM.

THE PERICARDIUM is a conical, membranous, closed sac, surrounding the heart and the roots of the great vessels. It occupies the greater part of the middle mediastinum, its apex upward, its base downward and attached to the central tendon of the diaphragm. It is a fibro-serous membrane, consisting of an outer fibrous coat and an inner serous coat. The latter is composed of a *visceral layer* reflected over the heart and vessels, and a *parietal layer* lining the inner surface of the fibrous sac. It secretes a thin, serous fluid.

The fibrous coat becomes continuous above with the deep layer of the cervical fascia, being prolonged upward on the outer surfaces of all the great vessels, except the inferior vena cava.

THE HEART.

The heart is a hollow, muscular organ, placed obliquely within the chest, and inclosed within the pericardium. Its base is directed upward and backward, opposite the fifth to eighth dorsal vertebræ; its apex downward to the left, opposite the interspace between the fifth and sixth costal cartilages. Its weight is about ten to twelve ounces in male, eight to ten in female; length five inches, breadth three and a half inches, thickness two and a half inches.

It is divided into four parts:—

Right auricle,	**Left auricle,**
Right ventricle,	**Left ventricle,**

an auricle and ventricle on each side. This division is indicated on both surfaces of the organ by two grooves crossing each other and named, from their position, the longitudinal the *interventricular,* the transverse the *auriculo-ventricular* grooves.

RIGHT AURICLE.—The right auricle consists of two portions—a *sinus* or *atrium* and an *appendix auriculæ,* which projects to the right side of the origin of the aorta. The walls at the fore and outer part and in the auricular appendage are thickened by musculi pectinati. Its interior presents the following parts:—

Openings of the *superior* and *inferior venæ cavæ,* neither of which are protected by valves;

Opening of *coronary sinus,* protected by a valve of two unequal segments—the coronary valve;

Foramina Thebesii, minute foramina returning the blood from the heart-muscle;

Eustachian valve, the remains of a fœtal structure, extending from the right of the orifice of the inferior vena cava to the outer border of the oval foramen;

Fossa ovalis, the obliterated foramen ovale of fœtal life;

Annulus ovalis, the oval margin of the preceding structure;

Tubercle of *Lower,* a small rudimental projection on the right wall, directing the blood toward the auriculo-ventricular opening:

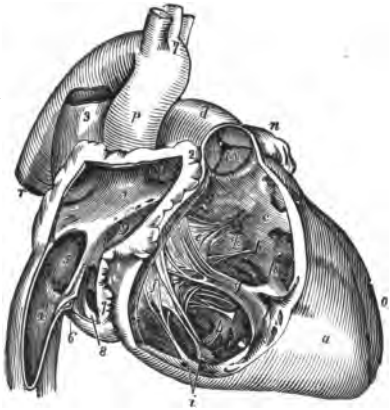


FIG. 104.

Right side of heart: a, apex; b, right ventricle; d, pulmonary artery; e, f, chordæ tendinæ; p, aorta; 3, superior vena cava; 5, inferior vena cava.

Musculi pectinati, elevated muscular columns before referred to;

Auriculo-ventricular opening, an oval aperture about one inch in diameter, surrounded by a fibrous ring, and protected by the *tricuspid* valve.

THE LEFT AURICLE.—The left auricle is smaller, and its walls somewhat thicker, than the right, and consists of a cuboidal sinus and an elongated appendix auriculæ. Its interior surface is smooth, except the auricular appendage, which is provided with musculi pectinati, and presents the following openings:—

Pulmonary veins, four in number, two on either side; they are without valves;

Auriculo-ventricular opening, an oval aperture, rather smaller than the right, and protected by the bicuspid or mitral valve.

THE RIGHT VENTRICLE.—The right ventricle is triangular, with thick walls (one-quarter inch), and occupies the anterior part of the organ. Its capacity is about three fluid ounces. It presents the following:—

Infundibulum, or *conus arteriosus,* a conical pouch, from which the pulmonary artery arises;

Columnæ carneæ, muscular columns projecting from the inner surface, three or four of which (musculi papillares) give attachment to the chordæ tendineæ;

Chordæ tendineæ, delicate tendinous cords, connecting the margins and central portions of the tricuspid valve with the columnæ carneæ;

Tricuspid valve, consists of three triangular duplications of endocardium, strengthened by fibrous tissue; they are attached by their bases to the auriculo-ventricular orifice, and their free margins give attachment to the chordæ tendineæ;

Semilunar valves, consist of three semicircular folds, guarding the orifice of the pulmonary artery; their free margins are thickened by nodules, the *corpora Arantii;*

Opening of the *pulmonary artery,* at the apex of the conus arteriosus, is circular in outline and protected by the semilunar valves;

Sinuses of Valsalva, three pouches, situated one behind each semilunar valve.

THE LEFT VENTRICLE.—The left ventricle is longer, more conical, and its walls three times as thick as the right. It forms the apex and most of the posterior portion of the heart. It presents the following parts in its interior:—

Columnæ carneæ, and

Chordæ tendineæ, much the same as the right;

Auriculo-ventricular opening, a little smaller than the corresponding orifice on the right side, similarly formed, and protected by the mitral valve;

The *mitral valve* consists of two unequal segments, attached the same as the tricuspid, and also affording attachment to the chordæ tendineæ;

Aortic opening, a circular opening to the right of the auriculo-ventricular opening;

The *semi-lunar valves,* three in number, surround the aorta, and are larger and stronger than those on the right side;

Sinus aortici (sinuses of Valsalva) are depressions situated behind each valve.

STRUCTURE OF THE HEART.—The heart is composed of finely striated muscular walls, with external serous covering from the pericardium and internal serous lining the *endocardium,* the latter continuous with that of blood-vessels. The endocardium is a thin, translucent membrane, consisting of endothelium and a fine basement membrane, beneath which is a fibro-elastic layer. The doublings of these layers constitute the valves. The tricuspid and mitral valves, as well as the aortic and pulmonary, are surrounded by a fibro-elastic ring, which furnishes a "punctum fixum" for the various muscles of the heart.

The *muscular structure* consists of an intricate interlacement of fibrous bands. Of these there are two groups—those of the auricles and those of the ventricles.

The former consist of a superficial transverse set and the internal or deep set, of which there are the looped and the circular.

The fibres of the ventricles consist of seven layers in a general oblique and circular manner, and terminating in a *whorl* or *vortex* at the apex, some of the fibres terminating in the columnæ carneæ, musculi pectinati, while others ascend, forming in their course a twisted loop like 8. The *arteries* of the heart are the right and left coronary. The *veins* are the anterior or great, middle or posterior cardiac, the left auricular, the right auricular, and venæ Thebesii. The *lymphatics* end in thoracic and right lymphatic ducts. The *nerves* are derived from the cardiac plexus of pneumogastric, spinal, and great sympathetic.

THE VASCULAR SYSTEM.

The vascular system consists of four sets of vessels—arteries, capillaries, veins, and lymphatics. Anastomoses are common.

The vessels that convey blood to and from the tissues of the body generally constitute the *general system.*

Those that carry blood to and from the lungs form the *pulmonary system.*

The vessels passing to the liver form the *portal system.*

THE ARTERIES, for the most part, are composed of three coats:—

Tunica adventitia, or external coat, consists of fibrous tissue, thinnest on the largest trunks, and disappears in those which merge into capillaries.

The *tunica media,* or middle coat, is thickest in the large trunks, and consists mainly of elastic tissue, together with some unstriated muscle and some connective tissue; in smallest arteries it consists alone of muscular tissue. The elastic tissue

in layers forms nets, constituting so-called *perforated* or *fenestrated membranes.*

The *tunica intima,* or internal coat, thinnest, most transparent, and elastic, is composed of lining endothelium, basement membrane, and layers of elastic tissue. It becomes continuous with capillaries. The walls of larger arteries are supplied by blood-vessels from neighboring arteries. Nutrient arteries form a net-work of capillaries, and returning veins empty into contiguous veins. The nerves are both medullated and non-medullated and chiefly pass to the muscle-fibres.

Arteries dilate and contract with the action of the heart, constituting the *pulse.*

THE VEINS.—Larger, more numerous, and more capacious than the arteries. With one exception (the portal vein) they convey blood to the heart. The large veins emptying into the heart are:—

Four pulmonary;

Superior and inferior venæ cavæ;

Coronary veins from walls of the heart through the coronary sinus.

The larger arteries have each one companion vein, the medium arteries two. In some positions they form venous plexuses, corresponding to arterial anastomoses.

Many large veins have valves, usually in pairs, attached by convex border.

There are, however, no valves in the pulmonary, superior and inferior cavæ, azygos, portal vein and branches, hepatic, renal, uterine, and spinal, and most of those of head or neck.

In certain membranes and organs channels exist, lined by internal coat of blood-vessel, termed venous sinuses, as in the dura mater, bones, and uterus.

The coats of the veins are similar to those of the arteries, and differ chiefly in the weakness of the middle or muscular coat, which allows them to remain open.

The *external* fibrous coat has also longitudinal, unstriated muscular tissue in veins of abdominal cavity:—

The *middle,* unstriated muscular and fibrous tissue;

The *internal,* no fenestrated membrane.

The walls have nutritive vessels, and are well supplied with non-medullated and medullated nerves, which pass to the muscular coat.

Both arteries and veins are insensitive in health.

THE CAPILLARIES communicate with the terminations of the arteries and veins, and do not communicate with tissue proper, which is supplied by imbibition. They vary in size in different

organs from $^1/_{3000}$ to $^1/_{2000}$ inch in diameter, but all permit the passage of blood-corpuscles. Their form is dependent on the form of tissue supplied.

COMPOSITION OF THE BLOOD.—Blood within the vessels is a perfect fluid, of alkaline reaction, saline taste, average specific gravity 1055, and feeble, peculiar odor. Within the arterial vessels it is bright-red color, becoming in the veins (particularly the venæ portæ and pulmonary arteries) a deep maroon or reddish-black color.

It constitutes about one-twelfth or one-fourteenth of the body-weight, and consists of the liquor sanguinis and the corpuscles, red, white, etc.

The *red corpuscles* are elastic, of specific gravity 1088, non-nucleated, and average about one three-thousandth line in diameter. A cubic millimetre of blood contains, in the male, 5,000,000 red blood-cells, and, in the female, 4,500,000. On evaporation they become stellate, and swell up with water. They vary much in size and shape in different animals, and contain hæmoglobin, which carries oxygen to the tissues and CO_2 to the lungs.

The *colorless* or *white blood-corpuscles* are free nucleated protoplasmic masses, capable of amœboid movement. They contain fat-corpuscles, myosin, cholesterin, protagon, glycogen, and nuclein. There is about 1 white corpuscle to every 500 red corpuscles, or in 1 cubic millimetre of blood there are present about from 8,000 to 10,000 white corpuscles.

The *liquor sanguinis* is a pale, amber-colored fluid, holding the corpuscles in suspension, and very prone to coagulate. The coagulation of the blood results in the formation of a clot, or crassamentum, and the serum, in the following manner:—

Fluid blood..... { Corpuscles. { White corpuscles. / Red corpuscles. } Clot.
Plasma or Liquor Sanguinis. { Fibrin. } Clot.
Plasma or Liquor Sanguinis. { Serum. } Serum.

The composition of the blood is about as follows:—

Corpuscles, 328.. { Water...200 / Solids....128 } { Salts, / Hæmoglobin, / Other organic compounds.

Plasma, 672..... { Water...604 / Solids.... 68 } { Fibrin, / Albumen, / Fat, / Other organic compounds, / Sodium and potassium salts, / Calcium and magnesium salts.

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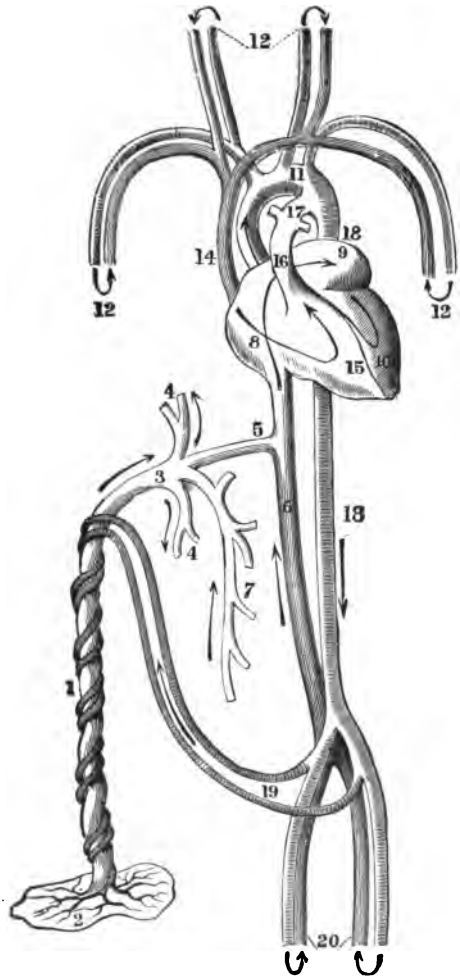

FIG. 105.

Diagram of the fœtal circulation: 1, umbilical cord, with veins and arteries; 2, placenta; 3, divisions of umbilical vein; 4, hepatic branches; 5, ductus venosus; 6, inferior vena cava; 7, portal vein; 8, right auricle; 9, left auricle; 10, left ventricle; 11, arch of aorta; 14, superior vena cava; 15, right ventricle; 16, pulmonary artery; 17, ductus arteriosus; 18, descending aorta; 19, umbilical arteries.

THE CIRCULATION OF THE BLOOD.

Fœtal Circulation.—The fresh arterial blood returning from the placenta through the umbilical vein enters the fœtus at the umbilicus, passes along the suspensory ligament to the under surface of the liver, where a portion passes directly into the inferior vena cava by the junction of the ductus venosus with the left hepatic vein, a portion enters the liver and reaches the inferior vena cava through the hepatic veins, and the larger portion mixes with the portal venous blood before reaching the vena cava through the hepatic veins. It ascends in the inferior vena cava along with the venous blood from the trunk and lower extremities to enter the right auricle of the heart (Fig. 105). Here it is directed by the Eustachian valve through the foramen ovale into the left auricle, into the left ventricle, and so through the aorta, chiefly to the head and upper extremities, a small portion only entering the descending aorta. It is returned by the superior vena cava to the right auricle, passes over the Eustachian valve to the right ventricle, and so through the pulmonary artery toward the lungs, but (the lungs being almost impervious) most of it passes through the ductus arteriosus into the descending aorta (mixing with the small quantity from the left ventricle before mentioned) to supply the lower extremities, abdominal and pelvic viscera, and as venous blood to return through the umbilical arteries to the placenta.

Circulation After Birth and in Adult.—The dark venous blood from the entire body is received through the superior and inferior venæ cavæ and coronary sinus into the right auricle, from whence it passes into the right ventricle, to be sent through the pulmonary artery into the lungs. Here it becomes oxygenated, and as bright arterial blood it returns to the left auricle by the pulmonary veins, and passes into the left ventricle, from whence it is distributed through the aorta and its branches to the entire body.

AORTA.

This is the main trunk of the systemic arteries. Commencing at the upper part of the left ventricle, it ascends for a short distance, arches backward over the right pulmonary artery, the root of the left lung, to the left side of the body of the fourth dorsal vertebra, from where it passes downward through the diaphragm and becomes the abdominal aorta. It then descends to the lower border of the fourth lumbar vertebra, where it terminates by dividing into the left and right common iliac arteries.

In its course it is divided into the arch, the thoracic aorta, and the abdominal aorta, the arch being subdivided into the ascending, transverse, and descending portion.

Relations.—The *ascending portion* of the arch is in relation on the right side with the superior cava and right auricle; on the left side with the pulmonary artery; in front, with the pulmonary artery, the pericardium, the right appendix auriculæ, and the thymus gland; and behind, with the root of the right lung and the right pulmonary vessels.

The *transverse portion* of the arch is in relation in front with the left lung and pleura, the left pneumogastric and phrenic nerves, the superficial cardiac nerves, the left superior intercostal vein, and the thymus gland; behind, with the trachea, the œsophagus, the thoracic duct, the deep cardiac plexus, and the left recurrent nerve; above, with the arteria innominata, the left innominate vein, the left subclavian, and the left carotid; and below, with the left bronchus, the bifurcation of the pulmonary artery, the left recurrent nerve, and the remains of the ductus arteriosus.

The *descending portion* of the arch is in relation in front with the root of the left lung and the pleura; behind, with the left side of the body of the fifth dorsal vertebra; on the right side with the thoracic duct and œsophagus; and on the left side with the pleura.

The branches of the aorta are, from the arch:—

Two coronary,	Left common carotid,
Innominate,	Left subclavian.

THE CORONARY ARTERIES supply the heart and are two in number—the right and the left. The right arises from the aorta, above the right semi-lunar valve, and passes downward in a groove between the right auricle and ventricle on its posterior surface, dividing into two branches, one of which anastomoses with the left coronary. The left coronary arises above the left semi-lunar valve and descends in the anterior interventricular groove, where it divides into two branches, one of which anastomoses with the right coronary.

ARTERIA INNOMINATA.—This is the largest branch from the arch of the aorta. It ascends to the upper border of the right sterno-clavicular articulation, where it divides into the right common carotid and the right subclavian arteries. It is a short vessel, from one and a half to two inches long.

Relations.—It is in relation in front with the sternum, the sterno-hyoid and sterno-thyroid muscles, the left innominate and right inferior thyroid veins, the thymus gland, and the cardiac branch from the right pneumogastric; behind, with the trachea; on the right side, with the pleura and right vena innominata and right pneumogastric nerve; on the left side, with the left carotid and the thymus gland.

THE COMMON CAROTID ARTERIES.—The left common carotid, arising directly from the arch of the aorta, is longer and ascends more obliquely and is more deeply placed than the right.

From the sterno-clavicular articulation to their division at the upper border of the thyroid cartilage the common carotid on either side pursues the same course. At the lower part of the neck the two vessels are separated by a very short interval, which is occupied by the trachea, but at the upper part they diverge widely, the larynx, pharynx, thyroid body, and several muscles being interposed between them. It ascends the neck in a direction indicated by a line drawn from the sterno-clavicular articulation to midway between the mastoid process and the angle of the lower jaw.

Relations.—It is in relation in front with the sterno-mastoid, sterno-thyroid, sterno-hyoid, and omo-hyoid muscles, the anterior jugular and the superior and middle thyroid veins, the sterno-hyoid artery, and the descendens and communicans noni nerves; behind it rests upon the longest colli and rectus capitis anticus major muscles and is in relation with the sympathetic nerve, the recurrent laryngeal nerve, and the inferior thyroid artery; on the outer side, with the pneumogastric and the internal jugular vein; to the inner side, the larynx, trachea, pharynx, thyroid gland, inferior thyroid artery, and the recurrent laryngeal nerve.

THE EXTERNAL CAROTID ARTERY.

From its commencement at the superior border of the thyroid cartilage it passes upward and forward and then backward, beneath the anterior margin of the sterno-mastoid muscle, in a direction indicated by an imaginary line drawn from the superior border of the thyroid cartilage to a point midway between the meatus and the neck of the condyle of the lower jaw. It ascends through the space known as the *superior triangle of the neck.*

Relations.—It is in relation in front with the parotid gland and the facial nerve and temporo-maxillary passing through it, covered by the skin, superficial platysma, and deep fascia, and is crossed by the digastric and stylo-hyoid muscles, hypoglossal nerve, lingual and facial veins; behind it is separated from the internal carotid by the parotid gland, stylo-glossus and stylo-pharyngeus muscles, and the glosso-pharyngeal nerve, and at its lower part the superior laryngeal nerve ascends behind it; to its inner side it is in relation with the pharynx, hyoid bone, superior laryngeal nerve, and the ramus of the lower jaw, from which it is separated by the parotid gland.

The branches of the external carotid are eight:—

1. Superior thyroid,
2. Lingual,
3. Facial,
4. Occipital,
5. Posterior auricular,
6. Ascending pharyngeal,
7. Temporal,
8. Internal maxillary.

1. SUPERIOR THYROID arises below the great cornu of the hyoid bone, passes beneath the sterno-hyoid, omo-hyoid, and sterno-thyroid muscles to the upper part of the thyroid gland, where its terminal branches anastomose with its fellow of the opposite side. Its branches are:—

a. Hyoid, to the lower border of the hyoid bone;
b. Superficial descending branch, crosses the common carotid artery to supply the skin and sterno-mastoid muscle;
c. Superior laryngeal, passes beneath the thyro-hyoid muscle with the superior laryngeal nerve;
d. Crico-thyroid, crosses the crico-thyroid membrane.

2. The LINGUAL ARTERY arises from the anterior part of the external carotid, between the superior thyroid and the facial. It passes inward and upward to the greater cornu of the hyoid bone, and, descending, reaches the under surface of the tongue and runs along its under surface as far as its tip, where it terminates as the ranine.

In its course it passes through a triangle bounded on two sides below by the two bellies of the digastric, and above by the hypoglossal nerve, passing under the hyoglossus muscle. Its branches are:—

Hyoid, to the hyoid bone;
Dorsalis linguæ, supplies the epiglottis, soft palate, tonsil, and the mucous membrane of tongue;
Sublingual, supplies mylo-hyoid and genio-hyoglossus muscles and sublingual gland;
Ranine, the terminal branch, ends at the tip of the tongue.

3. The FACIAL ARTERY arises from the anterior portion of the external carotid artery above the lingual. It ascends forward through the submaxillary gland, crosses the lower jaw at the anterior border of the masseter muscle, and crosses the cheek to the angle of the mouth and the side of the nose, where it terminates as the angular artery. Its branches are in the neck:—

Inferior or ascending palatine, supplies the soft palate, palatine glands, tonsil, and Eustachian tube;
Tonsillar, supplies the root of the tongue and tonsil;
Submaxillary, supplies the submaxillary gland and neighboring lymphatics, muscles, and skin;
Submental, supplies the chin, lower lip, and neighboring structures;
Muscular, to the buccinator, masseter, and internal pterygoid muscles.

In the face:—

Muscular, to the same muscles given above;

Inferior labial, to the skin of the lower lip;

Inferior coronary, to the mucous membrane, muscles, and glands of the lower lip;

Superior coronary, to the structures of the upper lip and nasal septum;

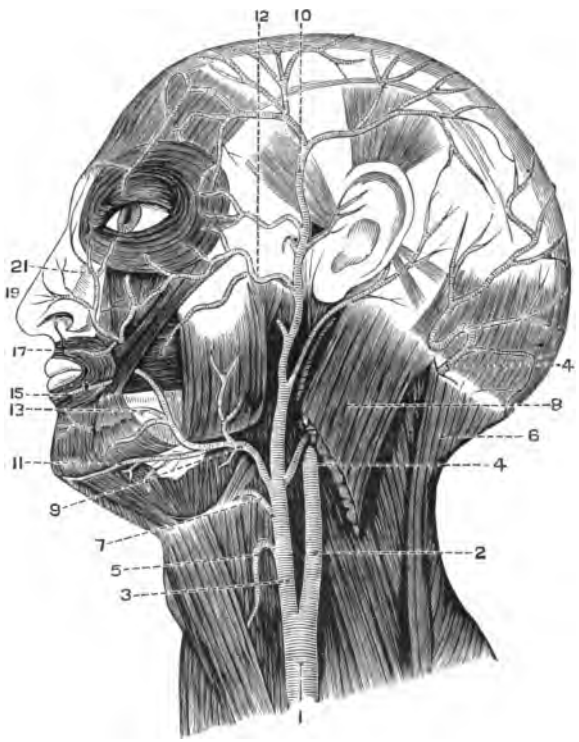

FIG. 106.

Arteries of face and head: 1, common carotid; 2, internal carotid; 3, external carotid; 4, occipital; 5, superior thyroid; 7, lingual; 9, facial; 10, temporal; 11, submental; 12, transverse facial; 13, inferior labial; 15, 17, inferior and superior coronary; 19, lateral nasal; 21, angular.

Lateralis nasi, to the skin of the nostrils, anastomoses with the nasal branch of ophthalmic;

Angular, supplies lachrymal sac and skin. All of these branches anastomose freely with the neighboring arteries.

4. The OCCIPITAL ARTERY arises from the posterior portion of the external carotid, about the lower border of the digastric muscle. It passes beneath the stylo-hyoid muscle, the digastric muscle, and part of the parotid gland, and, ascending, grooves the internal surface of the mastoid portion of the temporal bone and distributes itself over the occiput as high as the vertex. Its branches are:—

Muscular, to splenius, digastric, stylo-hyoid, etc.;
Sterno-mastoid, crosses the hypoglossal to the sterno-mastoid muscle;
Auricular, is distributed to the back part of the concha;
Meningeal, passes through the foramen lacerum posterius to the dura mater;
Arteria princeps cervicis. Its superficial branch anastomoses with the superficial cervical, and its deep branch with the deep cervical branch from the superior intercostal.

Cranial branches are distributed to the scalp over the occiput.

5. The POSTERIOR AURICULAR ARTERY arises from the posterior portion of the external carotid, on a level with the apex of the styloid process. It ascends beneath the parotid gland to a point between the mastoid process and the cartilage of the ear, where it divides into two branches, one going to the ear and the other to the occiput. Its branches are:—

Stylo-mastoid, supplies the mastoid cells, tympanum, and semicircular canals, entering the cranium through the stylo-mastoid foramen;
Auricular, supplies the cartilage of the ear;
Muscular, supply the sterno-mastoid, digastric, and stylo-hyoid muscles;
Glandular, to parotid gland.

6. The ASCENDING PHARYNGEAL artery arises about the commencement of the external carotid artery and ascends to the base of the skull upon the rectus capitis anticus major. Its branches are:—

Pharyngeal, supplies the three constrictors of the pharynx and the stylo-pharyngeus muscles;
External, to the neighboring muscles, glands, and hypoglossal and pneumogastric nerves;
Meningeal, enter the skull through the posterior and middle lacerated foramina and the anterior condyloid foramen.

7. The TEMPORAL artery is the smaller of the two terminal branches. It arises in the parotid gland, crosses the root of the zygoma, ascends forward a couple of inches, and divides into

the anterior temporal and the posterior temporal. Its branches are:—

Transverse facial, supplies the masseter muscle, parotid gland, and skin;

Middle temporal, crosses the face to supply the temporal muscle and fascia;

Anterior auricular, supplies the lobule, external meatus, and front part of pinna.

8. The INTERNAL MAXILLARY is the larger of the two terminal branches of the external carotid. It arises in the parotid gland about the level of the lower part of the lobe of the ear,

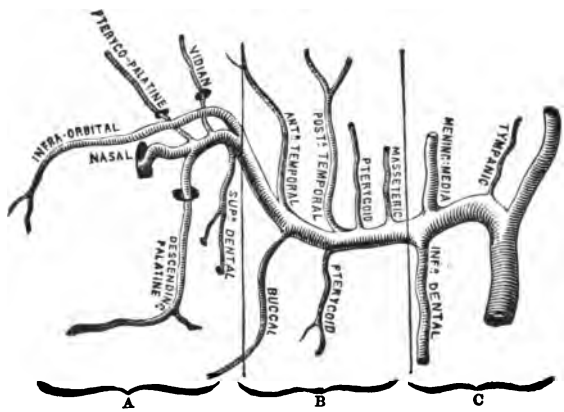

FIG. 107.

Internal maxillary artery: A, third portion; B, second portion; C, first portion.

passing close to the inner side of the neck of the condyle of the lower jaw to be distributed to the deep structures of the face. Its course is divided into three portions: the *maxillary portion,* passing inward and forward between the internal lateral ligament and the ramus of the jaw; the *pterygoid portion,* passing upward and forward upon the external pterygoid muscle; and the third part, or *spheno-maxillary,* enters the spheno-maxillary fossa. Its branches are, from the maxillary portion:—

Tympanic (anterior), supplies the tympanum through the Glaserian fissure, forming a capillary plexus on the tympanic membrane;

Middle meningeal, enters the cranium through the foramen spinosum, supplies the dura mater, and gives off a *petrosal branch* to facial nerve in hiatus Fallopii;

Small meningeal, or meningea parva, enters foramen ovale to supply dura mater and Gasserian ganglion;

Inferior dental, accompanies the dental nerve through the lower jaw to the mental foramen, supplying the structures.

The pterygoid portion:—

Deep temporal, supply the temporal muscle;
Pterygoid, to pterygoid muscles;
Masseteric, to the masseteric muscle;
Buccal, to the buccinator muscle.

Spheno-maxillary portion:—

Alveolar or posterior dental branch, supplies the upper molar and bicuspid teeth, antrum, and gums; its principal branch is the superior dental;

Infraorbital, passes through infraorbital canal to face;

Posterior or descending palatine, descends posterior palatine canal and runs forward to foramen of Stenson;

Vidian, accompanies the Vidian nerve;

Pterygo-palatine, supplies Eustachian tube and pharynx;

Nasal, or spheno-palatine, descends through spheno-palatine foramen to antrum, sphenoidal, and ethmoidal cells.

THE INTERNAL CAROTID ARTERY

arises about the upper border of the thyroid cartilage from the bifurcation of the common carotid. It ascends in front of the transverse processes of the cervical vertebræ to the carotid foramen in the petrous portion of the temporal bone to supply the anterior part of the brain, the eye with its appendages, and send branches to the nose and forehead. It gives no branches until it passes through the carotid canal, where, after piercing the dura mater at the anterior clinoid process, it divides into its terminal branches—the anterior and middle cerebral.

Relations.—The internal carotid artery in the neck is in relation in front with the parotid gland, the glosso-pharyngeal nerve, the stylo-glossus and stylo-pharyngeal muscles, and is covered by the skin, superficial and deep fascia; behind it rests upon the rectus capitis anticus major and has resting upon it the superior laryngeal nerve and the sympathetic; internally it is in relation with the pharynx, tonsil, superior laryngeal nerve, and ascending pharyngeal artery; externally it is in relation with the internal jugular vein and the pneumogastric nerve.

Its branches are, from the petrous portion:—

Tympanic (internal or deep), supplies tympanum.

From the cavernous portion:—

Arteriæ receptaculi, supply the Gasserian ganglion and pituitary body;

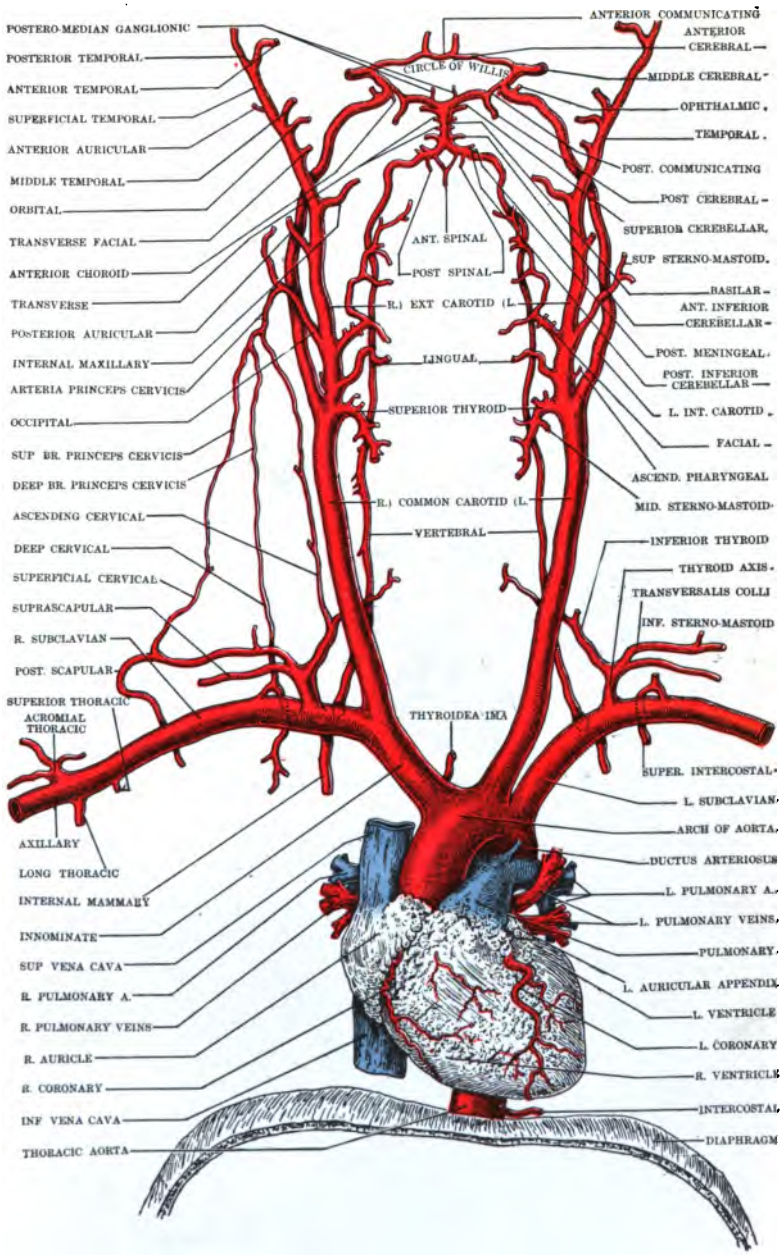

FIG. 108.

The arteries of the head and neck.

Anterior meningeal, a branch from the preceding vessel to the dura.

OPHTHALMIC arises about the position of the anterior clinoid process and passes through the optic foramen to the outer side of the optic nerve to reach the orbit. At the inner angle of the eye it divides into its two terminal branches—the frontal and the nasal. It supplies the muscles and the globe of the eye, and its branches may be divided into two groups—the orbital and the ocular.

Orbital group:—

Lachrymal, supplies the lachrymal gland and gives off a malar branch which passes through the malar bone to the temporal fossa;

Supraorbital, passes out through the supraorbital foramen to supply the surrounding structures;

Posterior ethmoidal, descends through the posterior ethmoidal foramen to the cells and adjacent parts;

Anterior ethmoidal, through the anterior ethmoidal foramen to the nose;

Palpebral, supply the eyelids;

Frontal, supplies the skin and muscles of the forehead.

Nasal, supplies the lachrymal sac and bridge of the nose.

Ocular group:—

Muscular, supply the muscles of the eye;

Anterior ciliary, supply the iris, piercing the sclerotic near the cornea;

Short ciliary, supply the choroid and ciliary processes, piercing the sclerotic near the optic nerve;

Long ciliary, enter with the short ciliary, but run forward to the iris;

Arteria centralis retinæ, supplies the optic nerve and the retina.

From the cerebral portion:—

Anterior cerebral, supplies the anterior part of the cerebrum, the optic and olfactory nerves, and communicates with its fellow by the anterior communicating;

Middle cerebral, or Sylvian artery, ascends in the Sylvian fissure, and supplies the middle lobes of the cerebrum;

Posterior communicating, runs backward to join the posterior cerebral;

Anterior choroid, supplies the choroid plexus.

THE CIRCLE OF WILLIS

is an anastomotic circle formed at the base of the brain about the pituitary body, between the branches of the internal carotid and the vertebral arteries, for the purpose of equalizing the cerebral circulation. The anterior cerebrals, from the internal carotids, pass forward and are united in front by a short trunk, the

anterior communicating. The posterior communicating unites the internal carotid with the posterior cerebral, the latter being the terminal branches of the basilar, which in its turn is formed by the union of the two vertebrals.

THE SUBCLAVIAN ARTERY

on the right side arises from the arteria innominata, behind the right sterno-clavicular articulation, and on the left side directly from the arch of the aorta. They pass outward to the outer margin of the first rib, where they become the axillary, being divided in their course by the scalenus anticus muscle into three portions—the first portion to the inner side of the muscle, second portion behind it, and the third portion between its outer margin and the lower border of the first rib. The vessels differ only in their first portions, the left ascending more vertically.

Relation.—The first portion of the right subclavian is in relation in front to the internal jugular and vertebral veins, the sterno-hyoid and sterno-thyroid and the clavicular portion of the sterno-mastoid muscles, and the pneumogastric, phrenic, and cardiac nerves; behind it is in relation with the longus colli muscle, the transverse process of the first dorsal or seventh cervical vertebræ, the sympathetic nerve, and the recurrent laryngeal nerve beneath with the pleura.

The first portion of the left subclavian artery is in relation in front with the left internal jugular and innominate veins, the left carotid artery, the sterno-thyroid, sterno-hyoid, and sterno-mastoid muscles, the pleura and left lung, and the pneumogastric, phrenic, and cardiac nerves; behind, with the vertebral column and longus colli muscle, the œsophagus, and thoracic duct, and the inferior cervical ganglion of the sympathetic; on the inner side with the œsophagus, thoracic duct, and trachea, and on the outer side with the pleura. The second portion of the subclavian artery on either side is in relation with the subclavian vein, the scalenus anticus muscle, and the phrenic nerve; behind with the middle scalenus muscle and pleura; above by brachial plexus, and below by the pleura. The third portion of the subclavian artery on either side is in relation in front with the external jugular vein and its branches, the clavicle, subclavius muscle and suprascapular artery, the descending branches of the cervical plexus and the cervical fascia; behind with the scalenus medius, above with the omo-hyoid muscle and the brachial plexus, and below with the first rib.

Its branches are:—

1. Vertebral,
2. Thyroid axis,
3. Inferior thyroid,
4. Suprascapular,
5. Transverse cervical, or transversalis colli,
6. Internal mammary,
7. Superior intercostal.

These branches are all given off from the first portion, except the superior intercostal, which arises on the right side, from the second portion.

anterior communicating. The posterior communicating unites the internal carotid with the posterior cerebral, the latter being the terminal branches of the basilar, which in its turn is formed by the union of the two vertebrals.

THE SUBCLAVIAN ARTERY

on the right side arises from the arteria innominata, behind the right sterno-clavicular articulation, and on the left side directly from the arch of the aorta. They pass outward to the outer margin of the first rib, where they become the axillary, being divided in their course by the scalenus anticus muscle into three portions—the first portion to the inner side of the muscle, second portion behind it, and the third portion between its outer margin and the lower border of the first rib. The vessels differ only in their first portions, the left ascending more vertically.

Relation.—The first portion of the right subclavian is in relation in front to the internal jugular and vertebral veins, the sterno-hyoid and sterno-thyroid and the clavicular portion of the sterno-mastoid muscles, and the pneumogastric, phrenic, and cardiac nerves; behind it is in relation with the longus colli muscle, the transverse process of the first dorsal or seventh cervical vertebræ, the sympathetic nerve, and the recurrent laryngeal nerve beneath with the pleura.

The first portion of the left subclavian artery is in relation in front with the left internal jugular and innominate veins, the left carotid artery, the sterno-thyroid, sterno-hyoid, and sterno-mastoid muscles, the pleura and left lung, and the pneumogastric, phrenic, and cardiac nerves; behind, with the vertebral column and longus colli muscle, the œsophagus, and thoracic duct, and the inferior cervical ganglion of the sympathetic; on the inner side with the œsophagus, thoracic duct, and trachea, and on the outer side with the pleura. The second portion of the subclavian artery on either side is in relation with the subclavian vein, the scalenus anticus muscle, and the phrenic nerve; behind with the middle scalenus muscle and pleura; above by brachial plexus, and below by the pleura. The third portion of the subclavian artery on either side is in relation in front with the external jugular vein and its branches, the clavicle, subclavius muscle and suprascapular artery, the descending branches of the cervical plexus and the cervical fascia; behind with the scalenus medius, above with the omo-hyoid muscle and the brachial plexus, and below with the first rib.

Its branches are:—

1. Vertebral,
2. Thyroid axis,
3. Inferior thyroid,
4. Suprascapular,
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These branches are all given off from the first portion, except the superior intercostal, which arises on the right side, from the second portion.

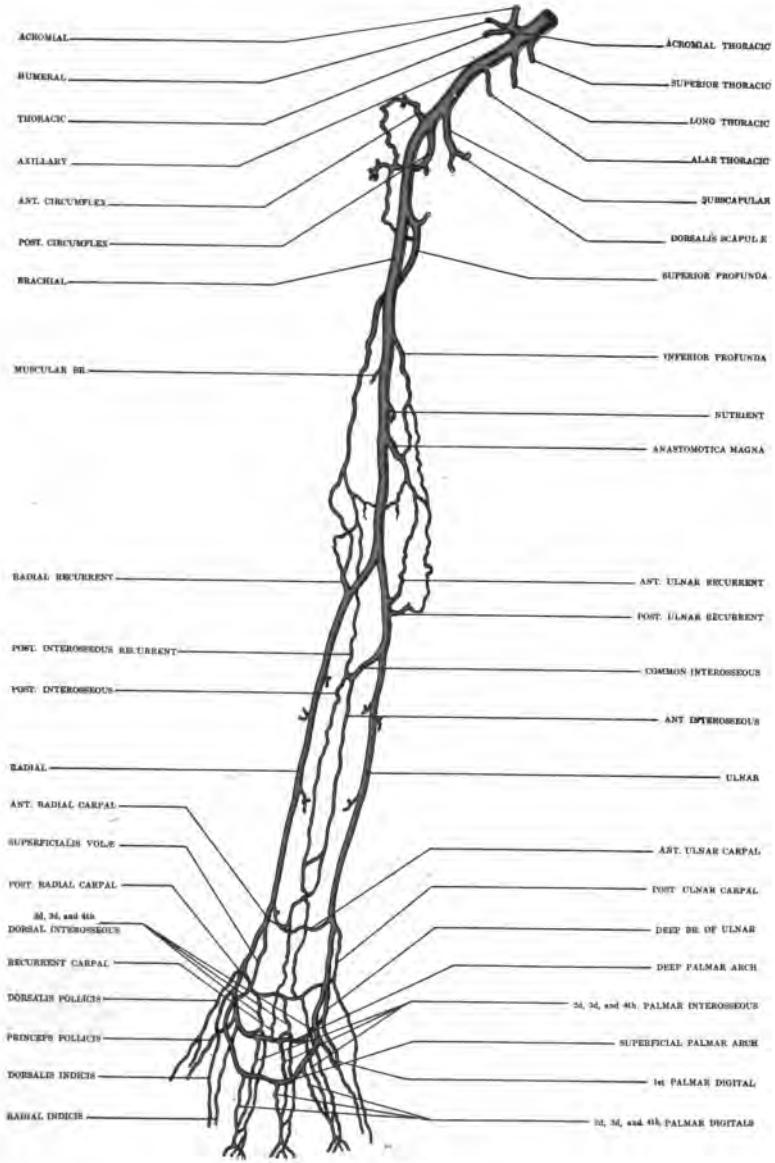


FIG. 109.

The arteries of the upper extremity.

1. The *vertebral artery* passes upward, enters the foramen in the transverse process of the sixth cervical vertebra, and ascends through the foramina until it reaches the atlas, when it runs backward, pierces the posterior occipito-atloid ligament and dura mater to enter the skull through the foramen magnum. After entering the cranium it passes forward to the lower border of the pons Varolii, where it unites with its fellow of the opposite side to form the basilar artery. Its branches are—

Cervical branches:—

Lateral spinal, supply the spinal cord and its membranes, entering the spinal canal through the intervertebral foramina;
Muscular, supply the deep muscles of the neck.

Cranial branches:—

Posterior meningeal, supply the falx cerebelli;
Anterior spinal, supplies the cord; uniting with branches from the inferior thyroid, intercostals, and lateral sacral, descend to the cauda equina;
Posterior spinal, descends in the same manner as the anterior;
Posterior inferior cerebellar, supplies the inferior surface of the cerebellum and the choroid plexus of the fourth ventricle.

The branches of the basilar artery are:—

Transverse, to the pons Varolii and inferior surface of the cerebellum;
Anterior inferior cerebellar, a branch of the transverse;
Superior cerebellar, supplies pia mater, pineal gland, and velum interpositum;
Posterior cerebral, to posterior lobes of cerebrum and choroid plexus.

2. The *thyroid axis* consists of three branches—the inferior thyroid, the suprascapular, and the transversalis colli.

3. The *inferior thyroid* artery is distributed to the thyroid gland, its branches being:—

Laryngeal, to muscles and mucous membrane of larynx;
Tracheal, to the trachea, anastomosing with the bronchial arteries;
Œsophageal, to œsophagus;
Ascending cervical, supplies the spinal cord and membranes, vertebræ, and muscles of neighborhood;
Muscular, to inferior constrictor of pharynx, scalenus anticus, and other muscles.

4. The *suprascapular artery* (transversalis humeri) passes beneath the posterior belly of the omo-hyoid to the upper border of the scapula, passing over the transverse ligament of the scapula to the supraspinous fossa, where it is distributed to the supraspinatus, sterno-mastoid, and other muscles, and by means of the

the condyles of the humerus, where it terminates by dividing into the radial and ulnar artery.

Relations.—It is covered in front by the skin, superficial, and deep fascia, and is crossed by the median nerve; behind it rests upon the triceps, brachialis anticus, and coraco-brachialis muscles;

And is in relation with the musculo-spiral nerve and the superior profunda artery; to the outer side above it is in relation with the biceps and coraco-brachialis muscles and the median nerve; and on the inner side with the internal cutaneous and ulnar nerve, and the basilic vein and median nerve below.

At the bend of the elbow it is crossed by the bicipital fascia. Its branches are:—

Superior profunda, accompanies the musculo-spiral nerve to supply the triceps, deltoid, and coraco-brachialis muscles;

Nutrient artery, supplies the shaft of the humerus;

Inferior profunda, accompanies the ulnar nerve to supply the triceps muscle and structures about the internal condyle;

Anastomotica magna, forms an anastomosis on the lower posterior aspect of the arm, with branches from the inferior profunda and recurrent ulnar vessels. It supplies the triceps;

Muscular, supply the muscles on the anterior aspect of the arm.

THE RADIAL ARTERY

descends from the bifurcation of the brachial below the bend of the elbow to the wrist, where it winds around the carpus beneath the extensor tendons of the thumb, passes between the two heads of the first dorsal interosseous muscle and into the palm of the hand, where it forms the deep palmar arch, anastomosing with the deep branch of the ulnar artery. Its branches are, in the forearm:—

Radial recurrent, supplies the brachialis anticus and supinator longus and brevis;

Muscular, supply the radial muscles;

Superficialis volæ, supplies the muscles of the thumb and anastomoses with the ulnar to form the superficial palmar arch;

Anterior carpal, supplies the wrist-joint.

In the wrist:—

Posterior carpal, supplies the wrist-joint, forms the posterior carpal arch, and gives off the dorsal interosseous arteries;

Metacarpal, is called the first dorsal interosseous; it supplies the index and middle finger;

Dorsales pollicis, supply the back of the thumb;

Dorsalis indicis, supplies the outer and dorsal side of the index finger.

In the hand:—

Princeps pollicis, supplies the sides of the palmar aspect of the thumb;
Radialis indicis, supplies the radial side of index finger;
Perforating, anastomose with dorsal interosseous arteries;
Interosseous, anastomose with digital branches of superficial palmar arch.

THE ULNAR ARTERY

descends from the bifurcation of the brachial below the bend of the elbow to the ulnar border of the wrist, passing beneath all the superficial flexors excepting the flexor carpi ulnaris, crosses over the annular ligament at the radial side of pisiform bone, and enters the palm to form the superficial palmar arch, anastomosing with the superficialis volæ from the radial. Its branches are, in the forearm:—

Anterior ulnar recurrent, supplies the pronator radii teres and brachialis anticus muscles;
Posterior ulnar recurrent, supplies the joint and neighboring muscles, and anastomoses freely;
Interosseous, passes backward to the upper border of the interosseous membrane, where it divides into
Anterior branch, descends on the front of the interosseous membrane;
Posterior, descends on the posterior aspect of the foramen and gives off a recurrent interosseous branch;
Muscular, to muscles on ulnar side of forearm.

In the wrist:—

Anterior carpal, supplies the front of wrist and anastomoses with the carpal branches of radial artery;
Posterior carpal, passes beneath the tendon of flexor carpi ulnaris and forms posterior carpal branch.

In the hand:—

Deep, or communicating branch, passes between the flexor and abductor minimi digiti to form part of deep palmar arch;
Digital, supply the ulnar side of the little finger and adjoining sides of the little, ring, middle, and index fingers.

THE DESCENDING AORTA.

The thoracic aorta extends from the lower border of the fifth dorsal vertebra on the left side to about the last dorsal vertebra, where by passing through the aortic opening in the diaphragm it becomes the abdominal aorta.

Relations.—It is in relation in front with the left bronchus, œsophagus, pericardium, and left pulmonary artery; behind it rests upon the

vertebral column and is in relation with the vena azygos minor; on the right side it is in relation with the thoracic duct, the œsophagus at its upper part, and the vena azygos major; on the left side with the left lung, the pleura, and the œsophagus below.

The branches of the thoracic aorta are:—

Pericardiac, supply the pericardium;

Bronchial, two or three in number, supply the bronchi;

Œsophageal, supply the œsophagus;

Posterior mediastinal, supply the neighboring pleura and lymphatic glands;

Intercostal, ten on each side, supply the intercostal spaces. They divide into—anterior branch, to intercostal and pectoral muscles; posterior branch, to spinal column and dorsal muscles.

THE ABDOMINAL AORTA

descends from the last dorsal vertebra at the aortic opening of the diaphragm, to opposite the fourth lumbar vertebra, a little to the left of the median line, where it divides into the two common iliac arteries.

Relations.—The abdominal aorta is in relation in front with the pancreas, transverse duodenum, stomach, and lesser omentum, the mesentery, splenic vein, left renal vein, cœliac, solar, and aortic plexuses; behind it is in relation with the vertebral column, the thoracic duct, the left lumbar veins, and the receptaculum chyli; on the right side with the inferior vena cava, vena azygos, thoracic duct, the right crus of tne diaphragm above, and the right semilunar ganglion; on the left side with the left semilunar ganglion and the sympathetic nerve.

The branches of the abdominal aorta are:—

Phrenic, two in number, supply the diaphragm;

Cœliac axis, divides into three large branches, the gastric, hepatic, and splenic;

1. *Gastric,* or coronaria ventriculi, is the smallest, and supplies the lesser curvature of the stomach;

2. *Hepatic,* enters the transverse fissure of the liver, and divides into two branches to supply the lobes of the liver. It gives off:—

Pyloric, to lesser curvature of stomach;

Gastro-duodenalis, which descends behind the pylorus, and divides into

Pancreatico-duodenalis superior branch to supply the pancreas and duodenum;

Gastro-epiploica dextra, along the greater curvature of the stomach from right to left.

Cystic, supplies the gall-bladder.

3. *Splenic,* the largest of the three, supplies the spleen and gives off the

(a) Pancreatic—to the pancreas;
(b) Gastro-epiploica sinistra, runs from left to right, along the greater curvature, to join the gastro-epiploica dextra;
(c) Gastric (vasa brevia), supply the fundus of the stomach.

Superior mesenteric, supplies the small intestine (except first part of the duodenum) and the large intestine as far as the splenic flexure, and part of the descending colon. It gives off:—

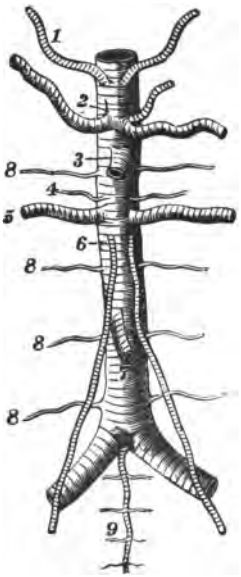


FIG. 110.

Abdominal aorta: 1, phrenic; 2, cœliac axis; 3, superior mesenteric; 4, suprarenal; 5, renal; 6, spermatic; 7, inferior mesenteric; 8, lumbar; 9, sacra media.

(a) Inferior pancreatico-duodenal, supplies duodenum and pancreas;
(b) Vasa intestini tenuis, supply nearly the whole length of the small intestine (ileum and jejunum);
(c) Ileo-colic, descends to the right iliac fossa, between the layers of the mesentery, and divides into two branches;
(d) Colica dextra, passes to the middle of the ascending colon, to divide into two branches;
(e) Colica media, ascends in the layers of the transverse mesocolon, to divide into two branches.

Suprarenal, supply the suprarenal bodies;

Renal, supply the kidneys, a large trunk on each side springing directly from the aorta;

Spermatic, descend to supply the testicles, and in their passage form one of the constituents of the spermatic cord;

Inferior mesenteric, gives off:—

(a) Colica sinistra, supplies the descending colon;
(b) Sigmoid, supplies the sigmoid flexure of the colon;
(c) Superior hæmorrhoidal, the continuation of the inferior mesenteric, supplies the mucous and muscular coats of the rectum on its posterior aspect.

Lumbar branches, four or five on each side, pass backward and outward and divide into the

Dorsal branches, supply the spinal cord, muscles, and skin of back;

Spinal branches, divide within the spinal canal, ascend and descend, and form an arterial net-work throughout the whole length of the spinal canal;

Abdominal branches, supply the abdominal walls;

Middle sacral, is the continuation of the abdominal aorta, descending in the middle of the sacrum to the upper part of the coccyx.

THE COMMON ILIAC ARTERIES

descend from the bifurcation of the abdominal aorta, opposite the body of the fourth lumbar vertebra, to a point midway between the last lumbar vertebra and the sacrum, where they divide into the external and internal iliac arteries. The right common iliac is a little larger than the left, and passes more obliquely outward.

Relations.—The right common iliac is in relation in front with the small intestine, the ureter, the peritoneum, and the sympathetic nerves; behind, with the left and right common iliac veins, and to its outer side it rests upon the psoas muscle, and is in relation with the vena cava and the right common iliac vein. The left common iliac is in relation in front with the ureter, the peritoneum, the superior hæmorrhoidal artery, and the sympathetic nerves; behind with the left common iliac vein, to its outer side the psoas muscle, and to its inner side the left common iliac vein.

The common iliac arteries give off a few unimportant branches to the ureters, peritoneum, etc.

THE INTERNAL ILIAC ARTERY

is about an inch and a half in length, extending from the bifurcation of the common iliac, about the sacro-lumbar junction, to

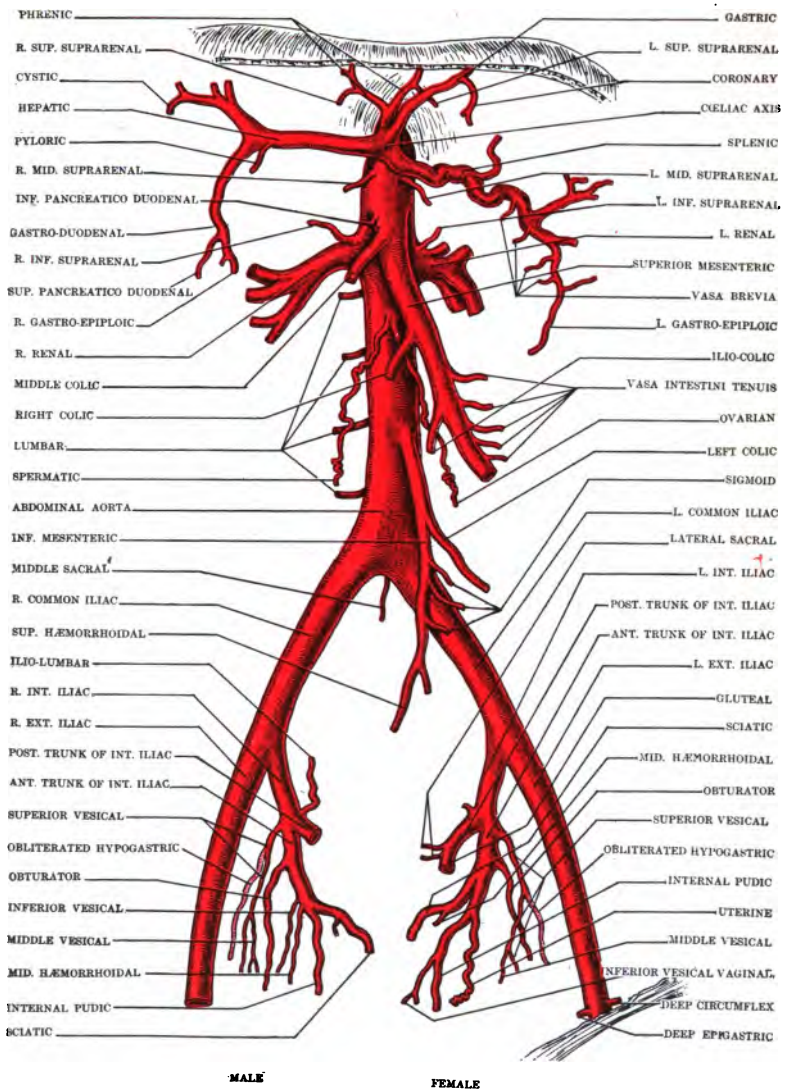


FIG. 111.

The arteries of the trunk.

the upper border of the great sacro-sciatic foramen, where it divides into the anterior and posterior trunks.

The branches from the anterior trunk are:—

Superior vesical, is the pervious remains of the fœtal hypogastric artery. It supplies the apex and body of bladder, ureter, and vas deferens;

Middle vesical, supplies the base of the bladder and part of vesiculæ seminales; it may be given off from the superior vesical;

Inferior vesical, supplies the prostate gland, base of bladder, and vesiculæ seminales;

Middle hæmorrhoidal, supplies part of the rectum;

Obturator, passes along the side of the pelvis to the obturator foramen, through which it passes. It gives off within the pelvis the iliac, vesical, and pubic branch;

Internal pudic, supplies the external organs of generation. It passes out of the pelvis through the great sacro-sciatic foramen, winds around the ischial spine, and re-enters the pelvis through the lesser sacro-sciatic foramen.

It gives off the following branches in the perineum:—

(a) Inferior hæmorrhoidal, supplies the muscles and skin of the anus;

(b) Superficial perineal, supplies the erector penis and accelerator urinæ muscles and the scrotum;

(c) Transverse perineal, crosses the perineum on the transversus muscle, which, together with the structures between the bulb and anus, it supplies;

(d) Bulbo-urethral, supplies the bulb of the spongy body and Cowper's gland;

(e) Cavernous, supplies the corpus cavernosum, and is one of the terminal branches;

(f) Dorsal artery of penis, or *clitoris,* runs forward on the dorsum and supplies the glans and prepuce.

The distribution of the internal pudic artery is much the same in the female as in the male, supplying analogous structures—the superficial artery to the labia, the artery of the bulb to the bulb of the vagina, the artery of the corpus cavernosum and dorsal artery to the clitoris.

Sciatic artery supplies the muscles at the back of the pelvis, coccygeus, pyriformis, and levator ani, and passes out of the great sacro-sciatic foramen to follow the course of the sciatic nerve. Its branches external to the pelvis are:—

Coccygeal, supplies back part of coccyx;
Inferior gluteal, to the gluteus maximus muscle;
Comes nervi ischiadici, runs in the substance of the great sciatic nerve;

Muscular, to the back part of the hip;
Articular, to supply the capsule of the hip-joint.

Uterine, is distributed to body of uterus, giving branches to the ureter and bladder;

Vaginal, supplies the mucous membrane of the vagina, giving branches to the rectum and neck of the bladder. It is analogous to the male inferior vesical.

From the posterior trunk

Ilio-lumbar gives off two branches:—

Lumbar, supplies quadratus lumborum and psoas muscles;

Iliac, supplies iliacus, gluteal, and abdominal muscles.

Lateral sacral, are two in number—the superior and inferior —supplying the contents of the sacral canal;

Gluteal, gives off a superficial and deep branch to supply the gluteus maximus, medius, and minimus muscles.

THE EXTERNAL ILIAC ARTERY

extends from the bifurcation of the common iliac to Poupart's ligament, under which it passes to become the femoral.

Relations.—It is in relation in front with the peritoneum and intestines, circumflex iliac vein, spermatic vessels, genito-crural nerve, and the lymphatic vessels and nerves; behind it rests upon the psoas muscle, and is in relation with the external iliac vein, which, together with the vas deferens, is also in relation to it on its inner side, beneath Poupart's ligament. On its outer side it is in relation with the psoas magnus and iliac fascia.

Its branches are:—

The deep epigastric, arises above Poupart's ligament and ascends obliquely inward between the transversalis fascia and peritoneum to the rectus muscle, in which it ascends to anastomose with the termination of the internal mammary artery. It gives off:—

Cremasteric branch, to supply the cremaster muscle;
Pubic, crossing Poupart's ligament to descend to the inner side of the femoral ring, and
Muscular, to supply abdominal muscles and the peritoneum.

The *deep circumflex iliac* ascends outwardly behind Poupart's ligament to the crest of the ilium, where it gives off

Muscular branches, to supply the abdominal muscles.

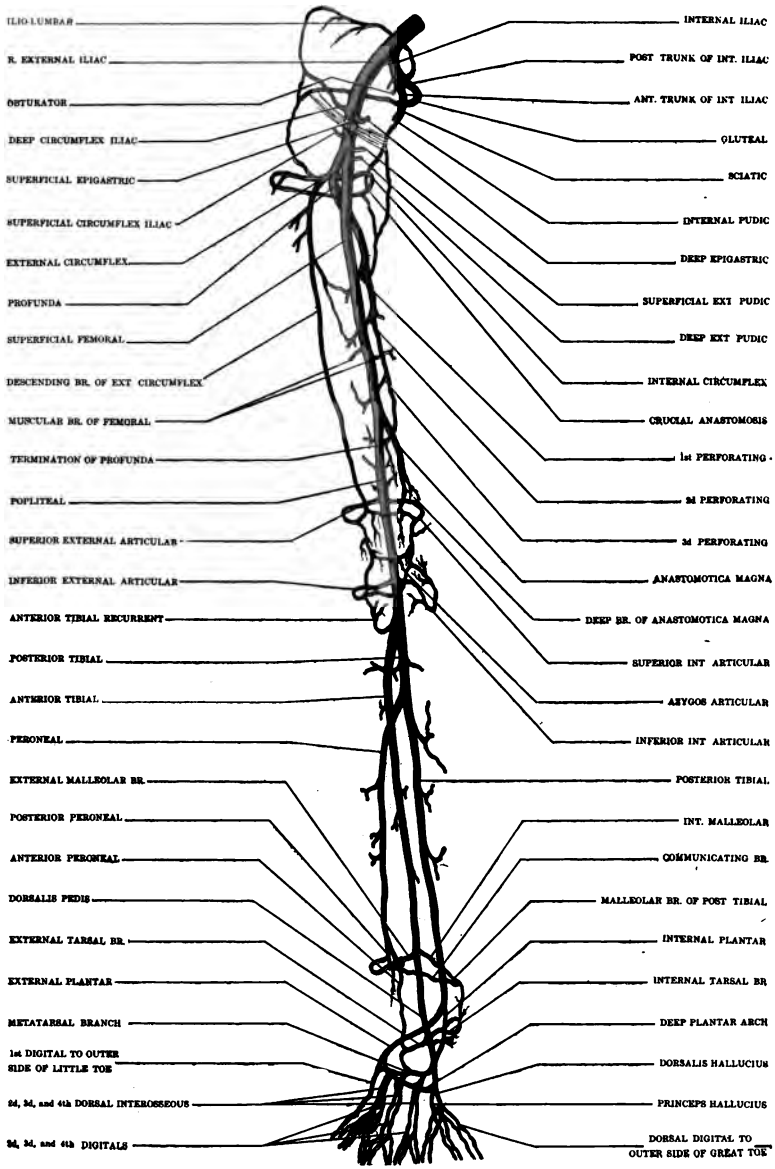


FIG. 112.

The arteries of the lower extremity.

THE FEMORAL ARTERY

extends from Poupart's ligament down the inner side of the thigh to the opening in the adductor magnus (Hunter's canal), where it becomes the popliteal. Its course corresponds to a line drawn from a point midway between the anterior superior spine of the ilium and the symphysis pubis to the inner tuberosity of the internal condyle. In the upper part of its course it is superficial, where it passes through Scarpa's triangle, but in the lower part it passes backward and becomes very deep. Where it passes under Poupart's ligament the femoral vein is to the inner side, and the anterior crural nerve to the outer side; thus, from within outward, V. A. N.

Relations.—It is in relation in front with the sartorius, the long saphenous nerve, a branch of the anterior crural nerve, and is covered by the fascia lata; behind it is in relation with the psoas magnus, adductor longus, adductor magnus and pectineus, and the profunda vein, and about the middle with the femoral vein; at its inner side it is in relation with the sartorius and adductor longus muscles, and at its upper part with femoral vein; on the outer side, with the vastus internus, and at its lower part, the femoral vein.

The branches of the femoral artery are:—

Superficial epigastric, descends through the saphenous opening in the fascia lata, and ascends in abdomen, supplying the skin, inguinal glands, and superficial fascia;

Superficial circumflex iliac, passes outward to the skin of the groin and over crest of ilium;

Superficial external pudic, supplies the skin on the lower part of the abdomen;

Deep external pudic, supplies the scrotum in the male, the labia pudendi in the female;

Profunda femoris, arises about two inches below Poupart's ligament, and passes beneath the adductor longus, giving off the following:—

External circumflex, gives off ascending, transverse, and descending branches, supplying the muscles on the front of the thigh as low as the knee;

Internal circumflex, passes internally, supplying the adductor muscles and the hip-joint;

Three perforating, pierce the adductor magnus and brevis, and supply the flexor muscles of the thigh, and give off the medullary nutrient artery. The vessel terminates by a fourth perforating.

Muscular, vary in number, and supply the sartorius and vastus internus;

Anastomotica magna, gives off two branches—superficial, accompanying the long saphenous nerve, and deep branch, to the inner side of knee, and supplies knee-joint.

THE POPLITEAL ARTERY

descends from the opening in the adductor magnus to the lower border of the popliteus muscle, passing behind the knee-joint, where it divides into the anterior and posterior tibial arteries. Its branches are:—

Muscular, gives off two principal branches:—

Superior, to flexors of thigh and vastus externus muscles;

Inferior, or sural, to heads of gastrocnemius and plantaris.

Cutaneous, supplies the skin of the calf;

Superior external articular, supplies knee-joint and vastus externus;

Superior internal articular, supplies knee-joint and vastus internus;

Azygos articular supplies the synovial membrane and ligaments of joints;

Inferior external articular, supplies knee-joint and fibular head;

Inferior internal articular, supplies knee-joint and head of tibia.

THE ANTERIOR TIBIAL ARTERY

descends from the bifurcation of the popliteal at the lower border of the popliteus muscle; passes over the upper border of the interosseous membrane, between the two heads of the tibialis posticus, and descends on the anterior part of the interosseous membrane and lower part of the tibia to the ankle-joint, where it terminates as the dorsalis pedis.

In the upper third of its course it lies between the tibialis anticus and extensor longus digitorum, resting upon the interosseous membrane, in the middle third, between the tibialis anticus and extensor proprius pollicis, and at the lower third it becomes more superficial, and lies between the extensor proprius and extensor longus digitorum tendons.

Its branches are:—

Recurrent tibial, ascends to supply the front and sides of the knee-joint and anastomose with the anastomotica magna and popliteal;

Muscular, supplying the muscles and skin of the neighboring parts;

Internal malleolar, arises two inches above the ankle-joint, and supplies it and the structures on its inner side;

External malleolar, supplies the outer side of the ankle.

THE DORSALIS PEDIS artery extends from the bend of the ankle, where it is continuous with the anterior tibial, to the first interosseous space, where it divides into the dorsalis hallucis and the communicating. Its branches are:—

Tarsal, supplies the tarsal articulations and the extensor brevis digitorum muscle;

Metatarsal, passes to the outer side of the foot, and gives off three interosseous branches to supply the adjacent sides of the toes;

Dorsalis pollicis, or hallucis, passes along the outer border of the great toe, supplying it;

Communicating, descends between the two heads of the first dorsal interosseous to complete, with the external plantar, the plantar arch;

Interosseous, branches of the tarsal branch, three in number.

THE POSTERIOR TIBIAL ARTERY

begins at the lower border of the popliteus muscle and descends along the posterior and tibial side of the leg to the space between the heel and the inner ankle, where it passes beneath the abductor pollicis and divides into the internal and external plantar arteries.

Relations.—In the upper part of its course it lies deeply, being covered by the gastrocnemius and soleus muscle, but in the lower part it becomes more superficial, being covered only by the skin and the fascia.

Its branches are:—

Peroneal, descends the inner border of the fibula, supplying the muscles and skin of that region and the back of the ankle;

Anterior peroneal, a branch of the peroneal, pierces the lower part of the interosseous membrane to supply the dorsum and outer side of the tarsus;

Muscular, supplies the posterior muscles;

Nutrient, supplies the tibia, being the largest nutrient artery in the body;

Communicating, passes to the peroneal;

Internal calcanean, supplies the inner side of the sole and heel.

THE INTERNAL PLANTAR ARTERY, the smaller of the two, passes along the inner side of the foot between the abductor pollicis and the flexor brevis digitorum to the inner border of the great toe, anastomosing with its digital branch.

THE EXTERNAL PLANTAR ARTERY passes across the foot to the base of the fifth metatarsal bone, where it turns inward and crosses the foot to the first interosseous space, where it anastomoses with the communicating branch of the dorsalis pedis to form the plantar arch. Its branches are:—

Posterior perforating, are three branches which pass between the heads of the dorsal interossei muscles;

Digital branches—these are four branches which supply the adjacent sides of the three outer toes, and the outer sides of the second and little toes.

TABLE OF THE ARTERIAL SYSTEM.

Aorta.

- Arch of aorta,
  - Right coronary,
  - Left coronary,
  - Innominate,
    - Right common carotid,
      - External carotid,
      - Internal carotid.
    - Right subclavian.
  - Left common carotid,
    - External carotid,
    - Internal carotid.
  - Left subclavian.

- External carotid,
  - Superior thyroid,
    - Hyoid,
    - Superficial descending branch,
    - Superior laryngeal,
    - Crico-thyroid.
  - Lingual,
    - Hyoid,
    - Dorsalis linguæ,
    - Sublingual,
    - Ranine.
  - Facial,
    - In the neck,
      - Inferior or ascending palatine, tonsillar, submaxillary, submental, muscular.
    - On the face,
      - Muscular, inferior labial, inferior coronary, superior coronary, lateralis nasi, angular.
  - Occipital,
    - Muscular,
    - Sterno-mastoid,
    - Auricular,
    - Meningeal,
    - Arteria princeps cervicis,
    - Cranial branches.

- External carotid continued,
  - Posterior auricular,
    - Stylo-mastoid,
    - Auricular,
    - Muscular,
    - Glandular.
  - Ascending pharyngeal, — Pharyngeal, external, meningeal.
  - Temporal,
    - Transverse facial,
    - Middle temporal,
    - Auricular,
    - Anterior temporal,
    - Posterior temporal.
  - Internal maxillary,
    - Maxillary portion,
      - Tympanic (anterior),
      - Middle meningeal,
      - Small meningeal,
      - Inferior dental.
    - Pterygoid portion,
      - Deep temporal,
      - Pterygoid,
      - Masseteric,
      - Buccal.
    - Spheno-maxillary portion,
      - Alveolar,
      - Infraorbital,
      - Post., or ascending palatine,
      - Vidian,
      - Pterygo-palatine,
      - Nasal or spheno-palatal.

- Internal carotid,
  - Petrous portion, — Tympanic (internal, or deep).
  - Cavernous portion,
    - Arteriæ receptaculi,
    - Anterior meningeal,
    - Ophthalmic,
      - Orbital group,
        - Lachrymal,
        - Supraorbital,
        - Post. ethmoidal,
        - Ant. ethmoidal,
        - Palpebral,
        - Frontal,
        - Nasal.
      - Ocular group,
        - Muscular,
        - Ant. ciliary,
        - Short ciliary,
        - Long ciliary,
        - Arteria centralis retinæ.
  - Cerebral portion,
    - Anterior cerebral,
    - Posterior cerebral,
    - Anterior choroid.
    - Posterior communicating.

- **Subclavian,**
  - **Vertebral,**
    - *Cervical Branches,*
      - Lateral spinal,
      - Muscular.
    - *Cranial Branches,*
      - Posterior meningeal,
      - Anterior spinal,
      - Posterior spinal.
    - **Basilar,**
      - Transverse,
      - Anterior inferior cerebellar,
      - Sup. cerebellar,
      - Post. cerebral.
  - **Thyroid axis,**
    - Inferior thyroid,
      - Laryngeal,
      - Tracheal,
      - Œsophageal,
      - Ascend. cervical,
      - Muscular.
    - Superior scapular, (Transversalis humeri),
      - Muscular,
      - Supra-acromial.
    - Transversalis colli,
      - Superfic. cervical,
      - Post. scapular.
  - **Internal mammary,**
    - Comes nervi phrenici (superior phrenic),
    - Mediastinal,
    - Pericardiac,
    - Sternal,
    - Anterior intercostal,
    - Perforating,
    - Musculo-phrenic,
    - Superior epigastric.
  - **Superior intercostal,** — Deep cervical branch (profunda cervicis).

- **Axillary,**
  - Superior thoracic,
  - Acromio-thoracic,
  - Thoracica longa,
  - Thoracica alaris,
  - Subscapular,
    - Subscapular,
    - Dorsalis scapulæ,
    - Median branch,
    - Posterior circumflex.
  - Anterior circumflex.

- **Brachial,**
  - Superior profunda,
  - Nutrient artery,
  - Inferior profunda,
  - Anastomotica magna,
  - Muscular,
  - Radial,
  - Ulnar.

- **Radial,**
  - In forearm,
    - Radial recurrent,
    - Muscular,
    - Superficialis volæ,
    - Anterior carpal.
  - In the wrist,
    - Posterior carpal,
    - Metacarpal,
    - Dorsalis pollicis,
    - Dorsalis indicis.
  - In the hand,
    - Princeps pollicis,
    - Radialis indicis,
    - Perforating,
    - Interosseus.
- **Ulnar,**
  - In the forearm,
    - Anterior ulnar recurrent,
    - Posterior ulnar recurrent,
    - Interosseous,
    - Muscular.
  - In the wrist,
    - Anterior carpal,
    - Posterior carpal.
  - In the hand,
    - Deep, or communicating branch,
    - Digital.

Descending Aorta.

- **Thoracic aorta,**
  - Pericardiac,
  - Bronchial,
  - Œsophageal,
  - Posterior mediastinal,
  - Intercostal.
- **Abdominal aorta,**
  - Two phrenic.
  - Cœliac axis,
    - Gastric.
    - Hepatic,
      - Pyloric,
      - Gastro-duodenalis,
        - Pancreatico-duodenalis superior,
        - Gastro-epiploica dextra.
      - Cystic,
    - Splenic,
      - Pancreatic,
      - Gastro-epiploica sinistra,
      - Gastric (vasa brevia).
  - Superior mesenteric,
    - Pancreatico-duo enalis inferior,
    - Vasa intestinalis tenuis,
    - Ileo-colic,
    - Colica dextra,
    - Colica media.
  - Suprarenal,
  - Renal,

- Abdominal aorta, continue!,
  - Spermatic,
  - Inferior mesenteric,
    - Colica sinistra,
    - Sigmoid,
    - Superior hæmorrhoidal.
  - Lumbar (four or five branches),
  - Dorsal branch,
  - Spinal branch,
  - Abdominal branches,
  - Middle sacral,
  - Common ilii.

- Common iliac,
  - Branches to ureter, peritoneum, etc.
  - Internal iliac, (Bifurcation.)
    - Anterior trunk,
      - Superior vesical,
      - Middle vesical,
      - Inferior vesical,
      - Middle hæmorrhoidal.
      - Obturator,
        - Within pelvis,
          - Iliac,
          - Vesical,
          - Pubic.
        - Without pelvis,
          - External and internal branches.
      - Internal pudic,
        - Inferior hæmorrhoidal,
        - Superficial perineal,
        - Transverse perineal,
        - Bulbo-urethral,
        - Cavernous,
        - Dorsal art'y of the penis.
      - Sciatic,
        - Coccygeal,
        - Inferior gluteal,
        - Comes nervi ischiadicis,
        - Muscular,
        - Articular.
      - In the female,
        - Uterine,
        - Vaginal.
    - Posterior trunk,
      - Ilio-lumbar,
      - Lateral sacral,
      - Gluteal.
  - External iliac,
    - Deep epigastric,
      - Cremasteric,
      - Pubic,
      - Muscular.
    - Deep circumflex iliac,
      - Muscular branches.

- **Femoral (continuation),**
  - Superficial epigastric,
  - Superficial circumflex iliac,
  - Superficial external pudic,
  - Deep external pudic.
  - Profunda,
    - External circumflex,
    - Internal circumflex,
    - Three perforating.
  - Muscular,
  - Anastomotica magna,
  - Popliteal (continuation).
- **Popliteal,**
  - Muscular,
    - Superior,
    - Inferior,
  - Cutaneous,
  - Superior external articular,
  - Superior internal articular,
  - Azygos articular,
  - Inferior external articular,
  - Inferior internal articular,
  - Anterior tibial, Posterior tibial, } Bifurcation.
- **Anterior tibial,**
  - Recurrent tibial,
  - Muscular,
  - Internal malleolar,
  - External malleolar.
  - Dorsalis pedis (continuation),
    - Tarsal, Metatarsal, } Three interosseous.
    - Dorsalis pollicis or hallucis,
    - Communicating,
    - Interosseous.
- **Posterior tibial,**
  - Peroneal, Anterior peroneal.
  - Muscular,
  - Nutrient,
  - Communicating,
  - Internal calcanean,
  - Internal plantar, External plantar, } Bifurcation.
- **Plantar arch (from external plantar),**
  - Three posterior perforating,
  - Four digital.

PULMONARY ARTERY.—The pulmonary artery carries venous blood from the right ventricle to the lungs. It is about two inches in length, passes upward and backward to the left side to the under surface of the transverse portion of the arch of the aorta, where it divides into the right and left pulmonary arteries. It is attached to the under portion of the arch by a fibrous cord, the remains of the ductus arteriosus of fœtal life. The right

pulmonary artery is larger and longer than the left, and passes behind the ascending aorta and superior vena cava to the root of the right lung, where it divides into two branches. The left pulmonary artery passes in front of the descending aorta and left bronchus to the root of the left lung, where it divides into two branches.

THE VENOUS SYSTEM.

The venous system, like the arterial, consists of two distinct sets, the *systemic* and *pulmonary*. It is composed of seven (7) main trunks and their branches:—

Systemic.	*Pulmonary.*
1. Coronary vein;	Four pulmonary veins.
2. Superior vena cava;	
3. Inferior vena cava.	

The systemic veins return the venous blood from the body, head, and extremities to the right auricle.

The portal vein, with its branches and capillaries, is an appendage to the systemic set, collecting the venous blood from the organs of digestion and carrying it to the liver, where it breaks into capillaries, and finally reaches the inferior vena cava by means of the hepatic veins.

The pulmonary veins are peculiar in carrying arterial blood from the lungs to the left auricle.

SYSTEMIC VEINS.—The *coronary sinus* returns all the blood from the substance of the heart, except that returned directly from the the walls of the right auricle by the *venæ Thebesii*. It is a dilatation of the great cardiac vein, about one inch in length, situated in the posterior part of the left auriculo-ventricular groove. It opens into the right auricle, its orifice being protected by the coronary valves, and receives the following:—

Great cardiac, or coronary vein;	Posterior cardiac;
Anterior cardiac;	Small cardiac;
Middle cardiac;	Oblique vein.

The *superior vena cava* is a short trunk formed by the union of the right and left innominate veins. It receives the vena azygos major, has no valves, and is smaller in size than the aorta. It ends in the right auricle, receiving the blood from the whole upper half of the body and the right lymphatic and thoracic ducts. The left innominate passes to join the superior cava in front of the great arteries of the arch. The inferior thyroid, the internal mammary, and vertebral veins follow closely the courses of the corresponding arteries, and terminate in the innominate vein.

The *internal jugular* vein is formed by the lateral and the superior petrosal sinuses, descends at the outer side of the common carotid behind the anterior border of the sterno-mastoid muscle, and joins the subclavian vein to form the innominate. At its junction with the subclavian the left internal jugular vein receives the thoracic duct and the right internal jugular vein the right lymphatic duct.

THE SINUSES OF THE DURA MATER.—These are venous channels analogous to veins between the layers of the dura mater. They are destitute of valves, follow no vessels, and their inner coat is continuous with the lining membrane of the veins. They are fifteen in number, divided into two sets, those at the back and upper part of the skull five in number:—

Superior longitudinal,	Lateral sinuses (2),
Inferior longitudinal,	Occipital sinus.
Straight sinus,	

And those of the base five also:—

Cavernous (2),	Superior petrosal (2),
Circular,	Transverse (anterior occipital,
Inferior petrosal (2),	Leidy).

The *superior longitudinal sinus* arises at the foramen cæcum, passes backward along the margin of the falx cerebri to the crucial ridge of the occipital bone, where it terminates in the torcular herophili (confluence of the sinuses).

The *inferior longitudinal sinus* passes in the free margin of the falx cerebri.

The *straight sinus* passes backward from the junction of the tentorium with the falx cerebri to enter the confluence of the sinuses.

The *lateral sinuses* pass horizontally outward from the confluence of the sinuses, torcular Herophili, along the temporal bone to the jugular foramen, where they terminate in the internal jugular vein.

The *occipital sinus,* the smallest of all the sinuses, commences at the margin of the foramen magnum on either side and passes backward to the confluence of the sinuses.

The *cavernous sinuses* pass from the sphenoidal fissure along either side of the sella turcica to the apex of the petrous portion of the temporal bone, where they join the petrosal sinuses. They are crossed by fibrous bands or offsets of the dura mater, and inclose the pathetic, motor oculi, abducens, and ophthalmic nerves, and the internal carotid artery, from which they are separated by the lining membrane.

The *circular sinus* is formed by two small vessels passing in front of and behind the pituitary body, and connecting the cavernous sinuses.

The *inferior petrosal sinus* on each side runs in a groove between the petrous portion of the temporal bone and the basilar portion of the occipital, connecting the cavernous sinuses with the lateral sinuses.

The *superior petrosal sinus* on each side passes along the upper border of the petrous portion of the temporal bone, connecting the cavernous with the lateral sinuses above.

The *transverse sinus* is a small, straight sinus, connecting the inferior petrosal and cavernous sinuses.

CEREBRAL VEINS.—The cerebral veins consist of two sets—the superficial, on the surface, and the deep, within the substance. They include:—

Superficial—

Superior cerebral veins,	**Inferior cerebral veins.**

Deep—

Ventricular veins, or venæ Galeni,	**Veni corporis striati, Choroid vein.**

The *cerebellar veins* consist of the superior, inferior, and lateral.

DIPLOIC AND MENINGEAL VEINS.—The *diploic veins,* five in number,—frontal, anterior temporal, posterior temporal, occipital,—communicate with the sinuses of the brain and with the veins of the dura mater, the scalp, and orbit.

The *meningeal veins* follow the course of the corresponding arteries, two accompanying each vessel through its course, and open into the sinuses of the dura mater.

The *great meningeal veins* terminate either in the cavernous sinuses or by emptying into the internal maxillary vein.

The *ophthalmic vein* commences at the internal canthus of the eye in an anastomosis with the facial, passes backward along the inner part of the orbit, through the sphenoidal fissure, to empty into the cavernous sinuses.

The *external jugular vein,* smaller than the internal jugular, is formed by the union of the posterior auricular with the temporo-maxillary veins; or it may be formed by union with the facial. It descends beneath the platysma muscle from the angle of the jaw to the middle of the clavicle, where it terminates by emptying into the subclavian. It receives the following veins:—

Anterior jugular,	**Suprascapular,**
Posterior jugular,	**Transverse cervical.**

The *facial vein* commences as the angular at the internal canthus of the eye, where it anastomoses with the ophthalmic vein, and receives the frontal vein. About the angle of the jaw it usually ends in the internal jugular, but sometimes empties into the external jugular or unites with the temporo-maxillary, to enter the external jugular. It receives—

Supraorbital and superior palpebral,	Labial,
Nasal veins,	Submental,
Inferior palpebral,	Submaxillary,
Buccal and masseteric,	Palatine.

The *temporal vein* is formed by the anterior temporal, which anastomoses with the frontal, and the posterior temporal, which anastomoses with the occipital. It penetrates the parotid gland and forms the temporo-maxillary vein by uniting with the internal maxillary. It receives

Articular veins,	Transverse facial,
Anterior auricular,	Parotid.
Middle temporal,	

The *internal maxillary vein* follows the course of the corresponding artery, and receives veins corresponding to the branches of that vessel. Some of these branches form the pterygoid plexus. It passes backward and unites with the temporal vein to form the temporo-maxillary.

The *temporo-maxillary vein,* formed by the junction of the internal maxillary in part or whole with the temporal, passes through the parotid gland and receives the posterior auricular, to form the external jugular vein.

The *occipital veins* follow the course of the artery, and terminate, usually, in the internal jugular; occasionally, in the external jugular. The mastoid vein, passing through a foramen in the mastoid portion, connects it with the lateral sinus.

VEINS OF THE TONGUE AND THROAT.—The *dorsal lingual,* formed by branches from the tonsils, epiglottis, and tongue, follow the course of the lingual nerve to empty into the facial, either jugular, or the pharyngeal.

The *ranine* pursues the course of the hypoglossal nerve, and terminates either in the facial or in one of the jugulars.

The *pharyngeal,* commencing in the pharyngeal plexus, receives branches from the brain, and terminates about on a level with the hyoid bone in the internal jugular.

The *superior thyroid* conveys the blood from the larynx, trachea, and thyroid gland to the internal jugular.

VEINS OF THE UPPER EXTREMITY.—Superficial and deep.

The *subclavian vein,* the continuation of the axillary, unites with the internal jugular to form the innominate. In its passage over the first rib it is separated from the artery by the scalenus anticus muscle.

Deep Set.—The deep veins accompany the corresponding arteries and form the venæ comites, one on either side, except the axillary, which has a single vein. The valves are more numerous in the deep set. About the middle of the arm one of the brachial veins receives the basilic vein, one of the larger veins of the superficial set. The two brachial veins unite with the basilic to form the axillary vein, which in turn becomes the subclavian vein, receiving in its course beneath the clavicle the cephalic vein, a branch of the superficial set.

Superficial Set.—The anterior ulnar vein commences on the inner surface of the hand and wrist, and terminates by uniting with the posterior ulnar or the median vein. The posterior ulnar vein commences on the inner back portion of the hand, anastomosing with the radial cutaneous vein, and ascends to the bend of the elbow, where it becomes the basilic vein;

The basilic vein, from its formation at the bend of the elbow, ascends the inner side of the biceps, pierces the fascia, to join the brachial vein.

The radial cutaneous commences on the radial, dorsal aspect of the hand, and at the bend of the elbow unites with the median cephalic, to become the cephalic.

The cephalic vein ascends along the outer border of the biceps, and above in the groove between the deltoid and pectoralis major, and passes beneath the clavicle, to end in the axillary.

The median vein receives the blood from the palmar surface of the hand and the front of the forearm, and usually divides into two branches—the median cephalic, passing outward to join the cephalic, and the median basilic, passing inward to join the basilic. The median basilic vein, the larger, is the one usually selected for plebotomy.

VEINS OF THE TRUNK.—The *vena azygos major* commences in the abdomen, opposite the first or second lumbar vertebra, as a continuation upward of the right ascending lumbar vein. It communicates with the right renal and the inferior vena cava. Through the lumbar veins it establishes communication with the right common iliac vein. It passes through the aortic opening of the diaphragm, or through an aperture in the right crus, ascends on the dorsal vertebræ, arches over the root of the right lung, and empties into the superior vena cava. It is in relation on its left side with the aorta, thoracic duct, and œsophagus. It receives

Vena azygos minor,	Right superior intercostal vein,
Vena hemi-azygos accessoria,	Right subcostal vein,
Lower end of left superior intercostal vein,	Œsophageal,
Lower 8 or 9 intercostal veins,	Right bronchial.

The hemi-azygos veins are two in number:—

The *vena azygos minor* arises on the left side, similarly to the azygos major, and passes through the left crus of the diaphragm and about the eighth dorsal vertebra crosses beneath the aorta to join the vena azygos major;

The *vena hemi-azygos accessoria* communicates with the upper left intercostal vein, and terminates either in the *vena azygos minor* or the azygos major.

The *inferior cava* formed by the junction of the common iliac veins, at the sides of the fourth lumbar vertebra, ascends on the right of the aorta, grooves the posterior border of the liver, and passes through the quadrate foramen in the central tendon of the diaphragm, and ends in the right auricle. It receives

Middle sacral,	Renal veins—the left, the longer, crosses in front of the aorta,
Lumbar,	Suprarenal,
Spermatic (from spermatic plexus),	Phrenic,
Ovarian (from ovarian plexus),	Hepatic (2 or 3).

The *portal vein,* about three inches in length, is formed by the inferior and superior mesenteric, the gastric, splenic, and pancreatic veins. It ascends in the right border of the lesser omentum to the transverse fissure of the liver, where it divides into the right and left. Its blood is distributed through the liver, mixing with the arterial blood from the hepatic artery, to be returned to the inferior cava by the hepatic veins. It receives

The superior mesenteric,	Cystic,
Splenic,	Inferior mesentery,
Coronary,	Right gastro-epiploic.

The portal vein and its branches are destitute of valves.

Veins of the Vertebral Column.—1. The *dorsi-spinal veins* commence in an intricate net-work surrounding the vertebral arches and their processes. They communicate with the intercostal, vertebral, intraspinal plexus, lumbar, sacral, and the superficial veins of the back.

2. The *intraspinal* or *meningo-rachidian veins* form an intricate plexus between the vertebræ and dura mater within the spinal canal. They consist of four longitudinal veins—two in

front and two behind. The *anterior longitudinal spinal veins,* two in number, extend along the sides of the vertebral bodies and opposite the bodies communicate by transverse trunks, which, in their passage beneath the vertebral ligament, receive the diploic veins, or *venæ basis vertebræ,* from the interior of the body. The *posterior longitudinal veins,* also two in number, smaller than the anterior, extend down the vertebral arches and are connected by transverse branches opposite the latter.

They receive the veins from the spinal cord and its membranes.

3. The *venæ basis vertebræ* return the blood from the bodies of the vertebræ into the anterior intraspinal plexuses.

The *venæ medulli spinalis* are the essential veins of the cord, situated between the arachnoid and pia mater.

Common Iliac Veins.

Formed by the internal and external iliac veins uniting opposite the sacro-iliac articulation, pass beneath the right common iliac artery to a point a little to the left of the body of the last lumbar vertebra, where they unite to form the inferior vena cava. The right is shorter and more vertical in its course, and both are without valves.

THE INTERNAL ILIAC VEIN corresponds to the distribution of the corresponding artery.

It receives the following venæ comites:—

Gluteal,	Internal pudic,
Sciatic,	Lateral sacral, and
Obturator,	Middle sacral;

and the following plexuses:—

Vesico-prostatic, Hæmorrhoidal,	in male;	Uterine and Vaginal,	in female.

The lateral and middle sacral form a small plexus—the plexus sacralis.

The veins of the rectum, bladder, and generative organs anastomose freely and form three plexuses:—

1. *Hæmorrhoidal plexus* encircles the lower part of the rectum, communicates with the sacral and prostatic plexuses, and veins from it join the inferior mesenteric, internal iliac, and pudic veins.

2. *Vesico-prostatic plexus* surrounds the membranous portion of the urethra, neck of bladder, prostate body, and seminal vesicles. It communicates behind with the hæmorrhoidal.

3. *Utero-vaginal plexuses.*—These correspond in the female with the prostatic, and communicate with the vesical and hæmorrhoidal plexuses, the ovarian, pudic, and through the *uterine veins* join the internal iliac veins.

During pregnancy these veins or plexuses become greatly distended and enlarged, forming the uterine sinuses, but retain a straight course.

The *pudic vein* follows the same course as the artery, communicates with the prostatic and hæmorrhoidal plexuses, and terminates in the internal iliac vein.

In the female it originates from the clitoris and perineum, and communicates with the vaginal plexus.

The *dorsal vein* of the *penis* returns the blood from the body of that organ. It commences as two venæ comites of the dorsal artery, which unite on the dorsal surface of the root of the penis, perforates the triangular ligament, and again divides to terminate in the prostatic plexus.

The *veins* of the *corpus cavernosum* emerge at the lower groove, and turn round their outer side to join the dorsal vein.

The *dorsal vein* of the *clitoris* has a corresponding origin and course, and empties into the vaginal plexus.

The EXTERNAL ILIAC VEIN, the continuation of the femoral, lies internal to the artery beneath Poupart's ligament, and joins the internal iliac opposite the sacro-iliac symphysis, to form the common iliac vein. It runs along the brim of the pelvis. It receives at its commencement the venæ comites of the epigastric artery and the circumflex iliac.

LOWER EXTREMITY.—The deep veins of the lower extremity pursue the exact course of the corresponding arteries, anastomosing across the vessels they accompany, except the femoral, which has but one vein.

The *popliteal vein,* formed by the junction of the anterior and posterior tibial veins, ascends to the lower margin of Hunter's canal, where it becomes the femoral. It receives the articular veins, sural veins, and the external saphenous. At its commencement it lies internal and superficial, at the middle of the space directly behind, and, in the upper part of its course, external to the artery.

The *femoral vein,* at first behind the artery, inclines to the inner side as it ascends, and at Poupart's ligament becomes the external iliac. It receives the profunda femoris, the internal saphenous vein, and numerous muscular veins.

The superficial veins of the lower extremity consist of two principal trunks: the *external short saphenous,* or vein, commences on the dorsum of the foot, passes behind the outer mal-

leolus, ascends the leg, and pierces the deep fascia in the popliteal space, to terminate in the popliteal vein. The *long saphenous vein,* and the larger, arises from the dorsum and inner side of the foot, ascends the front and inner side of the leg and thigh, and passes through the saphenous opening to join the femoral vein.

THE PULMONARY VEINS.—The pulmonary veins are four short, venous trunks, two from the base of each lung passing to the left auricle, returning arterial blood.

They differ from other veins in the following respects:—

1. They are without valves;
2. They carry arterial blood;
3. They accompany the arteries singly;
4. They are a little larger only than their arteries.

The right are longer than the left, and pass from the root of the lung, on a lower level than the artery, behind the aorta, superior cava, and right auricle, to enter the left auricle.

The Lymphatic System.

The lymphatic system includes the lymphatic vessels and glands and the lacteals, and forms an important accessory to the blood-vascular system, collecting the transuded, unappropriated fluids of the body and the nutritive material derived from the food and conveying it into the venous system.

It consists of two main trunks:—

(a) Thoracic duct; *(b)* Right lymphatic duct;

and five smaller trunks:—

1. Jugular lymphatic trunk;
2. Subclavian lymphatic trunk;
3. Broncho-mediastinal lymphatic trunk;
4. Lumbar lymphatic trunk;
5. Intestinal lymphatic trunk.

Lymphatics have been found in nearly every organ and texture in the body except the brain, the spinal cord, cartilage, tendon, eyeball, placenta, umbilical cord, membranes of the ovum, hair, cutis, and the labyrinth of the ear. They appear to originate as fine capillary nets interwoven among the blood-vessels and proper elements of the tissues, or, more minutely, in the lymph, perivascular, and perineural spaces. In the villi they commence as closed, club-like tubes.

The *lymphatic capillaries* are somewhat larger than the vascular capillaries and destitute of valves. Their main trunks pass through lymphatic glands lying in their course, before doing

which, however, they divide into afferent vessels, which, on emerging, unite into a smaller number of larger vessels, the efferent.

In structure, they are composed of three coats—the external fibro-areolar, middle muscular, and internal or endothelial and elastic.

The *lymphatic glands* are generally situated in the course of the blood-vessels, lymphatic vessels, or lacteal vessels, being accumulated together in certain localities, as the neck, abdomen, axilla, etc.

The lymphatic glands and vessels are named from the regions they occupy or the vessels they accompany, and consist usually of a superficial and deep set. Thus, we have cervical, axillary, mediastinal, lumbar, inguinal, etc., and the lymphatic vessels corresponding.

The *lacteals, or chyliferous vessels,* are the lymphatic vessels of the small intestine, and differ only from the others in carrying chyle during digestion from the intestines to the thoracic duct.

THE THORACIC DUCT is formed by the junction of the two lumbar lymphatic trunks with the intestinal lymphatic trunk, in front of the second lumbar vertebra, between the aorta and inferior vena cava, as the receptaculum chyli, or cistern of Pecquet. This receptacle is about one to two inches long and a quarter of an inch wide. From its origin the thoracic duct ascends through the abdomen, passes through the aortic orifice in the diaphragm, and ascends behind the œsophagus between the aorta and azygos vein to the fourth dorsal vertebra, where it passes to the left beneath the aorta, and ascends between the œsophagus and the left subclavian artery to the last cervical vertebra, where it arches forward, outward, and downward to enter the junction of the subclavian and the left internal jugular vein at its posterior aspect. Its orifice is protected by a pair of valves. It receives all the lymphatic vessels below the diaphragm, those of the left side of the head, neck, and left upper extremity.

THE RIGHT LYMPHATIC DUCT is about half an inch long and one-twelfth inch wide. It empties in a corresponding manner on the right side to the thoracic duct. It receives all the lymphatics of the right side of the thorax, neck, head, and right upper extremity.

LYMPHATICS OF THE HEAD AND NECK.—The substance of the brain is probably destitute of lymphatics, but they are very numerous in the pia mater and choroid plexuses of the lateral ventricles, and pursue the same course as the principal veins, to emerge at the base through the various foramina, to terminate in the deep cervical glands. The occipital lymphatic vessels terminate in the posterior auricular and occipital glands. The tem-

poral lymphatic vessels terminate in the anterior or auricular glands. The lymphatics of the face are superficial and deep. The superficial lymphatics are numerous, and terminate in the submaxillary glands, six or more in number; the deep lymphatics accompany the branches of the internal maxillary artery, and terminate in the deep cervical and deep parotid glands about the ramus of the jaw.

Lymphatics of the Upper Extremity.—Lymphatics of the upper extremity are composed of two sets, the superficial and deep. The *superficial lymphatic glands* are few in number, one or two only being situated at the internal condyle of the humerus. The deep lymphatic glands lie along the course of the vessels, and communicate with the axillary glands. All of these glands unite in the *deep axillary glands,* about eight to ten in number, which communicate with the deep cervical glands, and through them empty into the subclavian lymphatic trunk, to end finally in the thoracic or right lymphatic duct. The superficial and deep vessels of the thorax, the former in the skin, the latter from the mammary glands, pectoral and other muscles, for the most part, pass to the axilla, a few only terminating in the glands below the clavicle.

The Cavity of the Thorax.—The *intercostal* lymphatic vessels, derived from the side of the abdomen and thorax, pleuræ, diaphragm, spinal canal, muscles of the back, etc., follow the course of the veins, traverse fifteen to twenty intercostal glands near the heads of the ribs, and terminate in the thoracic duct. The *posterior mediastinal glands* are between the intercostal glands, and communicate with them. They receive vessels from the pericardium, œsophagus, and diaphragm. Some of the efferent vessels end in the bronchial glands, others in the thoracic duct. The *anterior mediastinal lymphatic vessels* are derived from the anterior wall of the abdomen and thorax, the diaphragm, pericardium, upper surface of the liver, heart, and thymus gland. They traverse about eighteen to twenty *anterior mediastinal glands,* situated in the course of the internal mammary vein, pericardium, and great vessels of the heart, and terminate in thoracic and right lymphatic ducts. The pulmonary lymphatic vessels consist of a superficial and deep set, traversing in the last part of their course the pulmonary glands. The *bronchial glands* are twenty or more glands at the bifurcation of the trachea and root of the lungs, and receive the lymphatic vessels of the lungs and bronchi. They become pigmented, and are often the seat of disease. Their efferent vessels terminate on the right side in the right lymphatic duct, either directly or by forming the broncho-mediastinal trunk, and on the left side into the thoracic duct.

LOWER EXTREMITY AND PELVIS.—The superficial lymphatic vessels from the back of the foot follow the course of the long saphenous vein, passing to the *superficial inguinal glands;* and those from the sole of the foot follow the short saphenous vein, joining the deep set in the popliteal space. The deep lymphatic vessels follow the deep veins, traverse two to four *popliteal glands,* and join the deep inguinal glands. The deep lymphatic glands in the pelvis consist of three sets: the *external iliac,* around the external iliac vessels; the *internal iliac,* around the internal iliac vessels; and the *sacral glands,* on the anterior surface, and in the mesorectal folds.

LYMPHATICS OF THE ABDOMEN.—The lymphatic vessels of the external and internal iliac glands enter the lumbar glands, twenty-five or more in number, situated upon the vertebræ, the origin of the diaphragm, the psoas and quadratus lumborum muscles, and the great blood-vessels. They receive vessels from the kidneys, ureters, loins, suprarenal bodies, ovaries, and testicles, and form lumbar lymphatic trunks, which ascend to join the thoracic duct or receptaculum chyli. The *lymphatic vessels of the stomach* follow the general course of the blood-vessels. They consist of three groups: the first, along the lesser curvature, passing to the glands along the pylorus; the second, at the great end of the stomach, passing to the splenic lymphatic glands; and the third, at the greater curvature, passing to one of the principal lacteal vessels. The *lymphatics* of the *small intestine* are called also lacteals. They pass between the layers of the mesentery and traverse a large number of mesenteric glands, arranged irregularly into three rows. The *lymphatic vessels* of the *large intestine* traverse the mesocolic glands, about thirty in number, and pass into the superior mesenteric glands. The vessels from the spleen and pancreas follow the course of the splenic vein, traverse a number of the glands, to end in the cœliac glands. The *lymphatics of the liver* consist of superficial and deep, and are very extensive, both on the upper and lower surfaces. They terminate in the right lymphatic duct, the glands of the gastrohepatic omentum, the anterior mediastinal glands, the œsophageal glands, the glands of the lesser curvature, and of the thoracic duct. The deep lymphatics follow the course of the portal vein and hepatic artery and duct, and, emerging, join one of the lacteal vessels before it enters into the thoracic duct. The *cœliac glands,* fifteen or twenty in number, are situated behind the pancreas and duodenum, the aorta, portal vein, cœliac, and superior mesenteric vessels. Their efferent vessels form the intestinal lymphatic trunk and empty into receptaculum chyli.

THE ALIMENTARY APPARATUS.

THE alimentary apparatus consists of the alimentary canal and of certain accessory organs.

The former is a musculo-membranous canal about thirty feet in length, extending from the mouth to the anus, and comprises: first, *the organs of deglutition,* consisting of the mouth, pharynx, and œsophagus; and, second, *the organs of digestion,* consisting of the stomach and small and large intestines. It is lined throughout by mucous membrane. The accessory organs comprise the teeth, salivary glands, liver, and pancreas.

Alimentary Apparatus.

- Alimentary canal,
  - Organs of deglutition,
    - Mouth,
    - Pharynx,
    - Œsophagus.
  - Organs of digestion,
    - Stomach,
    - Small intestine,
      - Duodenum,
      - Jejunum,
      - Ileum.
    - Large intestine,
      - Cæcum,
      - Colon,
      - Rectum.
- Accessory organs,
  - Teeth,
  - Salivary glands,
    - Parotid,
    - Submaxillary,
    - Sublingual.
  - Liver,
  - Pancreas.

THE MOUTH is an oval cavity in which mastication takes place preparatory to deglutition. It is placed at the entrance of the alimentary canal, is bounded laterally by the alveolar processes of the upper and lower jaws and cheeks; above by the upper teeth and hard palate; below by the tongue, the lower jaw, the mucous membrane between, and the lower teeth; in front by the lips; and behind by fauces and soft palate. It terminates posteriorly at the anterior pillars of the fauces, through the fauces into the pharynx.

It is invested throughout (except on the teeth) with highly vascular mucous membrane covered with stratified squamous epithelium containing conical papillæ.

It presents for examination the following parts:—

THE TEETH.—The teeth are firmly implanted within the alveoli of the jaws and surrounded by the gums.

The *gums* are composed of dense fibrous tissue, covered by smooth, vascular, mucous membrane of slight sensibility. This fibrous tissue is continuous with the periosteum of the jaws, and forms about the neck of the teeth a constricted ring—the *dental ligament.*

There are four kinds of teeth—incisors, canines or cuspids, premolars or bicuspids, and molars. MAN is provided with two sets of teeth, the temporary, deciduous, or milk teeth, which appear in childhood, and the permanent, which appear after the shedding of the milk teeth and last until old age.

The *temporary* or *deciduous teeth* are twenty in number, ten in each jaw, or five in each side of each jaw:—

Two incisors, one canine, and two molars.

The *permanent teeth* are thirty-two in number, sixteen in each jaw, or eight in each side of each jaw:—

Two incisors, one canine, two bicuspids, three molars.

Each tooth consists of three parts:—

Crown, or *body,* the enameled portion above the gum; *neck,* the constricted portion between the crown and root; *root,* or *fang,* within the alveolus, and covered with cement.

Characteristics.—Incisors, or cutting, are so called from their wedge-shaped, chisel-like crown, being adapted for biting or cutting the food. The fang is long, single, conical, and compressed at the sides.

Cuspids, or *canines,* have been so named from their conspicuous character in the canine or dog tribe.

The crown is large, conical, convex in front, and beveled behind. The fang is single, longest, and thickest of all the teeth.

Bicuspids, or *premolars.* The crown has a pair of projecting tubercles or cusps. Fang is conical, single, but deeply grooved, indicating a disposition to bifurcate.

Molars, commonly known as *grinders* or *jaw teeth.* Crown, broad, quadrilateral, with four cusps in upper, five in lower molars. Lower molars have usually a pair of fangs placed laterally; the upper, three fangs, two external and one internal.

The last or third molar has but one fang (with a tendency to divide into the same number of roots as the other molars), and is known as the *dens sapientiæ,* or "wisdom tooth," from its late appearance.

Structure.—On section a tooth consists of two portions, the pulp cavity and the solid portion surrounding it.

The solid portion consists of three structures, dentine, or ivory, which forms the principal mass of the tooth; enamel, which covers the crown, and cement, which covers the surface of the fang.

Dentine, or *ivory,* resembles bone, but differs from it in composition and structure, consisting of twenty-eight parts animal and seventy-two parts mineral matter, and being made up of minute tubuli held together by the intertubular substance.

The *dental tubuli* are minute cylindrical canals $^1/_{4500}$ of an inch in diameter. They pass in a spiral direction from the pulp cavity to the periphery.

Enamel, the hardest and densest of all organized bodies, contains but 3.5 per cent. animal matter, and is composed of minute hexagonal rods $^1/_{5500}$ of an inch in diameter, placed at right angles to the surface of the dentine. The external surface of unworn enamel can be separated as a thin, homogeneous membrane, *Nasmyth's membrane.*

Cement, or *crusta petrosa,* is a thin layer of true bone with canaliculi and lacunæ, disposed on the surface of the fang.

The *pulp cavity* is a cavity within the base of the crown, continuous with a canal in the centre of the fang, and open at the apex of the fang for the entrance of vessels and nerves. It is filled with dental pulp.

Dental pulp consists of two kinds of cells, the fusiform and the columnar, or *odontoblasts* of *Waldeyer,* held together by loose connective tissue. It is soft, vascular, and highly sensitive. The nerves are both medullated and non-medullated, and form a rich plexus beneath the odontoblastic layer. The terminal fibrils probably unite with these cells, but the exact distribution is still unsettled.

Development—Temporary.—They are formed very early, seven to eleven weeks, in the *primitive dental groove* by an involution of the epithelium of the oral cavity covering the maxillary arches into the blastema or corium and connective tissue below, the former forming the enamel, the latter the cement and dentine.

The enamel is formed by the *enamel germ* (a mass of epithelial cells) descending into the dental groove until it meets the *papilla,* a vascular growth extending upward from the connective tissue, upon which it forms a cap. A vascular membrane inclosing the enamel germ then extends itself—as the *dentinal sac*—upon the united papilla and enamel germ and cuts the latter off from its former epithelial structure. The cells become differentiated and finally calcify.

The dentine is formed by the development of odontoblasts in the periphery of the papilla in a similar manner to the development of osteoblasts in bone.

The cement is developed from the wall of the dental sac by the intramembranous process of ossification.

Permanent.—The *successional permanent teeth,* or those replacing the temporary, are formed in a different manner from the *superadded,* or three molars in each side of each jaw.

The former are developed similarly to the temporary teeth, but in a *secondary dental groove,* from which after their formation they recede behind the germs of the temporary teeth, inclosed in sacs. The molars, or superadded teeth, however, are formed by extensions backward of a portion of the enamel germ of the tooth immediately in front.

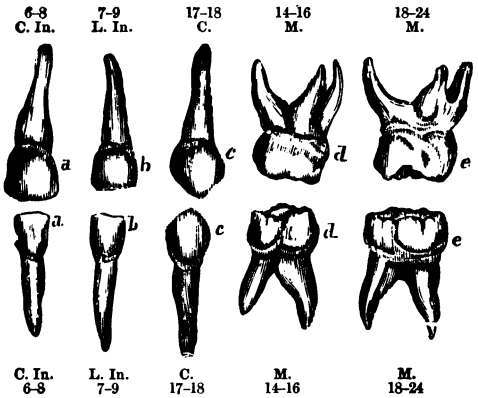


FIG. 113.—TEMPORARY TEETH.

Eruption, or "cutting of the teeth," takes place by the growth of the fang, the gums being absorbed by the pressure of the advancing crown. The development of the fangs of the permanent causes the absorption of the fangs of the temporary teeth through the agency of the *odontoclasts,* multinucleated cells corresponding to the osteoclasts of bone.

The eruption of the temporary teeth takes place in *months* in the order shown in Fig. 51, the lower preceding by a short time the upper (according to Dr. C. N. Pierce, in "American System of Dentistry"). The order of the eruptions is: first the lower central incisors, the upper central incisors, lateral incisors, upper and lower, first molars, followed by the canines or cuspids, and ending with the second molars.

The eruption of permanent teeth takes place in *years* as in Fig. 52, the order of the eruptions being, first the "first or sixth year molar," followed by the first central incisors, four lateral incisors, four first bicuspids, four second bicuspids, the first canines or cuspids, the four second molars, and ending with the four third molars or "wisdom teeth."

About the sixth year the jaws contain the temporary teeth fully erupted, and the crowns of all the permanent teeth excepting the four wisdom teeth, in all forty-eight.

It should be noted that the first permanent or "sixth-year" molar is erupted before any of the permanent teeth, and that the second bicuspid takes the place of the second temporary molar.

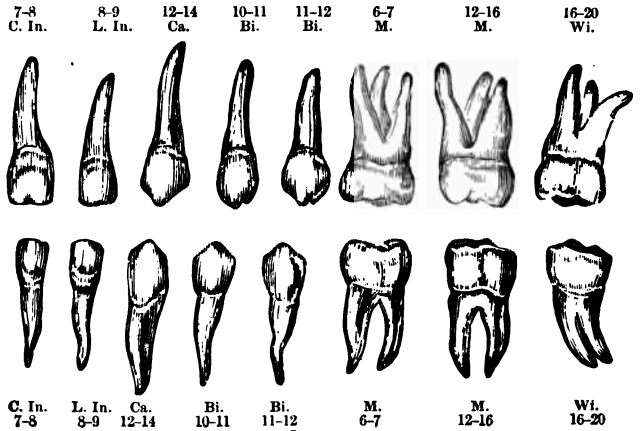


FIG. 114.—PERMANENT TEETH.

Vessels and Nerves of the Teeth.—The *arteries* of the upper teeth are derived from the anterior dental branches of infra-orbital and posterior or alveolar dental branches of the internal maxillary; of the lower teeth, from the inferior dental branch of the internal maxillary.

The *nerves* are distributed to the upper teeth from the anterior and posterior dental branches of the superior maxillary (second division of fifth cranial nerve), and to the lower teeth from the inferior maxillary (third division of fifth cranial nerve).

Soft palate is a movable fold of mucous membrane suspended from the posterior border of the hard palate, and inclosing an aponeurosis, vessels, nerves, glands, and the following

muscles on each side: tensor palati, levator palati, palatoglossus, palato-pharyngeus, and azygos uvulæ, the latter uniting with its fellow to form the *uvula.*

Hard palate is formed by the palatal process of the superior maxillary and the palate-bone, and covered by a thick, dense structure composed of mucous membrane and periosteum combined. It forms the roof of the mouth, and presents a median raphé and corrugated surface.

Anterior pillars of the fauces are folds of mucous membrane arching downward and forward from the base of the uvula to the base of the tongue, and inclosing the palatoglossus muscles.

Posterior pillars of the fauces are similar folds arching downward and backward from the base of the uvula to the sides of the pharynx, and inclosing the palato-pharyngeus muscles.

The *tonsils,* or amygdalæ, are small, almond-shaped, glandular bodies situated on each side of the fauces between the anterior and posterior pillars. They rest upon the superior constrictor of the pharynx, which separates them from the ascending pharyngeal and internal carotid arteries. They are composed of numerous follicles (lined by closed capsules containing adenoid tissue), which contain a thick, grayish secretion and open on the surface of the gland by a dozen or more orifices.

The *arteries* to the tonsil are from the tonsillar and ascending palatine of the facial, dorsalis linguæ from the lingual, ascending pharyngeal from external carotid, branch from small meningeal, and descending palatine branch of internal maxillary.

The *nerves* are from glossopharyngeal and Meckel's ganglion.

THE SALIVARY GLANDS.—The salivary glands communicating with the mouth are three: the parotid, submaxillary, and sublingual.

The *parotid gland,* so called from its location near the ear, is the largest, weighing from a half to one ounce. It occupies the space in front of the ear, bounded below by the angle of the jaw, and a line extended from it to the mastoid process, above by the zygoma, in front by the masseter muscle, and behind by the mastoid process, the external meatus, and the digastric muscle. The external carotid artery, the temporo-maxillary vein, the facial nerve, and the great auricular nerve pass through it.

The *duct* of the *parotid gland,* Steno's or Stenson's duct, empties its secretion into the mouth. It is about two and a half inches in length, of the diameter of a crow's quill, and crosses the face upon the masseter muscle, through the substance of the buccinator muscle, in the direction of an imaginary line

drawn about a finger's breadth below the zygoma, from the lower part of the ear to midway between the ala of the nose and the margin of the upper lip, to open about the position of the second molar tooth of the upper jaw.

Its *arteries* are branches of the external carotid. The *veins* empty into the external jugular. The *lymphatics* empty into the superficial and deep cervical glands, and the *nerves* are derived from the facial, from the superficial temporal branches of the great auricular, the auriculo-temporal, and sympathetic.

The *submaxillary gland* occupies the submaxillary fossa on the inferior surface of the inferior maxilla, within the submaxillary triangle of the neck. The facial artery grooves its upper and posterior border, and it is separated behind from the parotid gland by the stylo-maxillary ligament. The duct of the submaxillary gland, or Wharton's duct, about two inches in length, passes forward between the hyoglossus, geniohyoglossus, and mylohyoid muscles, to open at the side of the frænum linguæ.

Its *arteries* are from the facial and lingual; the veins follow the course of the corresponding arteries; the *nerves* are from the submaxillary ganglion, the sympathetic, and the mylohyoid branch of the inferior dental.

The *sublingual gland,* the smallest, lies on the floor of the mouth, at the side of the frænum linguæ, beneath the mucous membrane. Its ducts, called the ducts of Rivini, from eight to twenty, open on the mucous membrane. One of them, the longest, called the duct of Bartholin, joins Wharton's duct. Its *arteries* are from the submental and sublingual. The *nerves* are branches from the gustatory.

Besides these glands, the mucous membrane of the mouth is plentifully supplied with mucous glands.

THE PHARYNX is a musculo-membranous sac, extending from the basilar process of the occipital bone above to the level of the fifth cervical vertebra or the cricoid cartilage below. It is about four and a half inches in length. It has communicating with it seven openings:—

Two posterior nares,	Larynx,
Two Eustachian tubes,	Œsophagus,
Mouth.	

It is composed of three coats:—

1. *Fibrous coat,* or pharyngeal aponeurosis, attached above to the pharyngeal spine of the basilar process of the occipital bone; it affords attachment in the median line to the constrictor muscles of the pharynx.

2. *Mucous coat,* continuous with that of the various openings. It is covered in its upper part with columnar ciliated epithelium, as low as the floor of the nares, below which it is squamous. It contains numerous racemose glands, crypts, and lymphoid structure similar to the tonsils, a mass of which, between the Eustachian tubes, has been called the "pharyngeal tonsil."

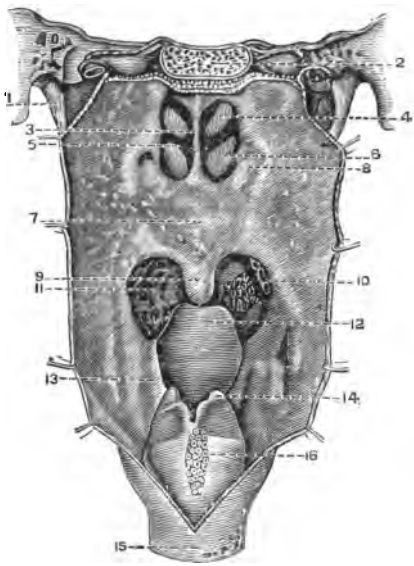


FIG. 115.

Pharynx laid open from behind: 1, styloid process; 2, body of occipital; 3, sæptum nasi; 4, middle turbinated bone; 5, posterior naris; 6, inferior turbinated bone; 7, soft palate; 9, uvula; 10, tonsil; 11, back of tongue; 12, epiglottis; 13, arytæno-epiglottidean fold; 14, tip of arytænoid cartilage; 15, œsophagus; 16, back of cricoid cartilage.

3. *Muscular coat,* consists of the three pharyngeal constrictors, the palato-pharyngeus, and the stylo-pharyngeus. (*Vide* Muscles.)

Arteries are from the inferior palatine, pharyngeal, and thyroid arteries. *Nerves* are branches of the pneumogastric, glosso-pharyngeal, and sympathetic.

THE ŒSOPHAGUS, or GULLET, is a musculo-membranous tube about nine inches long and less than one inch in diameter, flattened from before backward, and extending from the pharynx to the stomach or from the level of the fifth cervical to the ninth dorsal vertebra.

Relations.—In the neck the trachea is in front, the common carotids on either side, and in the chest the pericardium, the left carotid, left subclavian, the aorta, and the left bronchus are in front; the longus colli muscle and the intercostal vessels and the vertebral column are behind. The pleura covers it laterally, the descending portion of the arch of the aorta lying on the left and the vena azygos major on the right.

Its structure consists of three coats:—

Muscular coat, consisting of two layers, the longitudinal and the circular, continuous with the inferior constrictor;

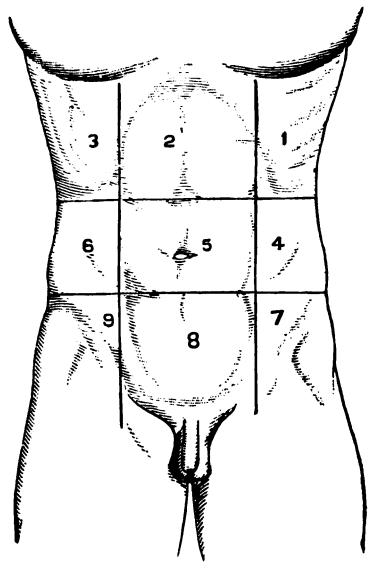


FIG. 116.

1, left hypochondriac region; 2, epigastric; 3, right hypochondriac; 4, left lumbar; 5, umbilical; 6, right lumbar; 7, left iliac; 8, hypogastric; 9, right iliac.

Areolar or *fibrous coat,* connecting the two;

Mucous coat, covered with stratified pavement epithelium, and having beneath it some non-striated muscular fibres, the muscularis mucosæ. It also contains numerous compound racemose glands, the œsophageal glands.

THE ABDOMEN.

The abdomen, the largest cavity in the body, is bounded in front and laterally by the abdominal muscles, the lower ribs, the ilii, and above by the diaphragm, below by the brim of the

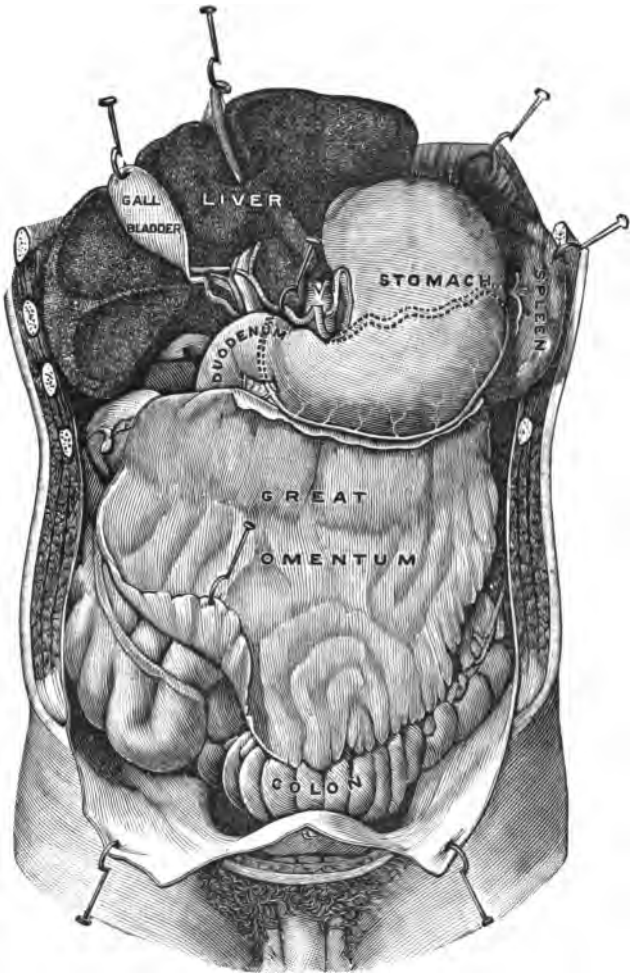


FIG. 117.

The abdominal viscera. (*Eckley.*)

pelvis, and behind by the vertebral column, quadratus lumborum, and psoas muscles. It is lined throughout by peritoneum, inclosing the greater portion of the alimentary canal. It has six openings, as follows:—

Aortic opening, for the vena azygos, aorta, and thoracic duct;
Œsophageal opening, for the œsophagus and pneumogastric nerves;
Quadrate opening, for the vena cava inferior;
Umbilicus, in front, for the fœtal umbilical vessels;
Femoral canal (*vide* femoral hernia);
Inguinal canal, for the round ligament in the female, and the spermatic cord in the male.

REGIONS OF THE ABDOMEN.—For convenience of study, the cavity of the abdomen is divided into nine regions by four imaginary lines, two circular lines drawn around the body, one at the lower margin of the thorax (Leidy) or on a level with the cartilages of the ninth ribs, the second at the highest point of the crest of the ilium; and two vertical lines, drawn from the cartilage of the eighth rib on each side through the centre of Poupart's ligament, or from the anterior inferior spinous process of the ilium, drawn upward (Leidy). These regions are named as follows:—

Right hypochondriac,	Epigastric region,	Left hypochondriac,
Right lumbar,	Umbilical region,	Left lumbar,
Right inguinal (iliac),	Hypogastric region,	Left inguinal (iliac).

Contents of Regions.

Right Hypochondriac.	*Epigastric.*	*Left Hypochondriac.*
Hepatic flexure of colon, right lobe of liver, gall-bladder, and upper part of right kidney.	Left lobe of liver, lobulus Spigelii, greater part of stomach, duodenum, and pancreas, portions of the kidneys and suprarenal capsules, vena cava, aorta, thoracic duct, semilunar ganglia.	Splenic flexure of colon, spleen, tail of pancreas, splenic end of stomach, and upper part of left kidney.
Right Lumbar.	*Umbilical.*	*Left Lumbar.*
Greater part of right kidney, ascending colon, and portions of the small intestine.	Transverse portions of colon and duodenum, jejunum, and ileum, part of mesentery and great omentum, receptaculum chyli, and portions of both kidneys.	Part of left kidney, descending colon, some convolutions of small intestine, and part of the omentum.

Right Inguinal (Iliac).	*Hypogastric.*	*Left Inguinal (Iliac).*
Right ureter, cæcum, spermatic vessels, and appendix cæci.	Portions of the small intestine under certain circumstances, the uterus (pregnant), bladder (distended), sometimes the cæcum, sigmoid flexure, and appendix.	Left ureter, sigmoid flexure of colon, and spermatic vessels.

PERITONEUM.—The peritoneum is a closed serous sac, its parietal layer lining the cavity of the abdomen, its visceral layer inclosing more or less completely all the abdominal and pelvic viscera. It is not in all cases a closed sac, for in the female it is continuous with the mucous membrane of the Fallopian tubes. It consists essentially of two sacs of unequal size, the greater and lesser peritoneal sacs, united by a central constriction—the foramen of Winslow:—

The *greater sac* is located in front of the viscera, one layer lining the internal abdominal wall, the other reflected upon the viscera. Its cavity is known as the *greater peritoneal cavity.*

The *lesser sac* covers the upper part of the posterior abdominal wall, and is reflected upon the posterior surface of the liver and stomach. Its cavity is called the lesser peritoneal cavity. It also gives off three processes, one of which is a broad, loose fold,—the *great omentum,*—passes downward from the greater curvature of the stomach between the two layers of the greater sac, and is reflected upon itself back to the under surface of the transverse colon.

The *foramen of Winslow* is a narrow canal, large enough to admit one finger, between the greater and lesser peritoneal cavities, located behind the right border of the lesser omentum, and formed by the hepatic and gastric arteries, constricting the sac at this point as they ascend from the cœliac axis. It is bounded as follows:—

In front, by the lesser omentum, containing the hepatic artery, portal vein, duodenum, and the ductus communis choledochus;
Behind, by the right crus of the diaphragm and the inferior vena cava;
Above, by the lobus Spigelii;
Below, by the hepatic artery.

Reflections.—The reflections of the peritoneum viewed in an antero-posterior section (the greater and lesser sacs together) may be traced as follows: From the diaphragm it is reflected to the upper surface of the liver. Enveloping this organ, it then presents a doubling or fold—the gastro-hepatic omentum—extending downward from the transverse hepatic fissure to the

lesser curvature of the stomach. Inclosing the stomach, it is reflected upon itself in front of the intestines as a broad apron—the *great omentum*—making a quadruple fold of peritoneum.

The two layers then embrace the transverse colon, unite, and pass back to the vertebral column, forming the *transverse mesocolon.* From here the layers separate, the upper one ascend-

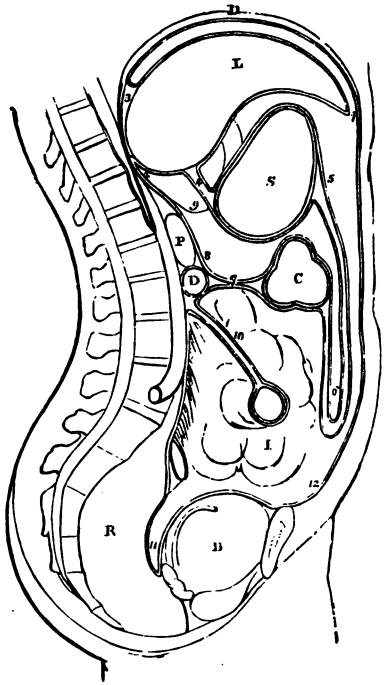


FIG. 118.

D, diaphragm; L, liver; S, stomach; P, pancreas; D, duodenum; C, colon; I, small intestine; B, bladder; R, rectum; 3, posterior surface of liver; 4, foramen of Winslow; 5, great omentum; 6, lesser omentum; 7, mesocolon; 8-9, lesser cavity of peritoneum; 10, mesentery; 11, recto-vesical fold.

ing in front of the pancreas to the starting point. The lower layer descends in front of the duodenum aorta, incloses the small intestine (forming the mesentery proper), is reflected upon the rectum (forming the mesorectum) and the bladder, and ascends upon the anterior abdominal wall to the starting point.

In the female, from the rectum it envelops the uterus and upper part of the vagina before reaching the bladder.

In addition to the folds seen in the antero-posterior section, the peritoneum passes between the various organs, and also laterally to the sides of the abdominal and pelvic cavities. In this manner are formed the right, left, and suspensory ligaments of the liver, the suspensory ligament of the spleen, the broad ligament of the uterus, and the three great ligaments or omenta of the stomach—the gastro-hepatic, gastro-splenic, and gastro-colic (already described) and the mesenteries.

The latter, the *mesenteries,* include the mesentery proper, mesocæcum; ascending, transverse, and descending mesocolon; sigmoid mesocolon, and mesorectum.

The *mesentery proper* is a broad fold, reflected from the vertebræ around the jejunum and ileum. Its base, attached obliquely from the left side of the second lumbar vertebra to the right iliac region, measures about six inches, while its expanded extremity is quite considerable.

In the male the recto-vesical folds, one on each side, pass from the rectum to the bladder, including between them the recto-vesical pouch. In the female, however, this pouch is divided into two—the recto-uterine and vesico-uterine pouches, the recto-vesical folds being called recto-uterine and vesico-uterine folds. Folds of peritoneum (superior false ligaments of the bladder) ascend from the bladder to the umbilicus, inclosing the remains of the fœtal urachus and hypogastric arteries, and also a fold on each side follows the course of the epigastric arteries toward the umbilicus, dividing the inguinal region into the internal, middle, and external inguinal fossæ. The peritoneum at the external inguinal fossa (corresponding to the internal abdominal ring) is continuous in the male fœtus with the tunica vaginalis testis, and in the female forms a blind sac about the round ligament—the *canal of Nuck.*

Viscera Partly Invested by Peritoneum.

Vagina—upper part;
Bladder—posterior wall;
Duodenum—descending and transverse portions;
Cæcum;
Colon—ascending and descending;
Rectum—middle portion.

Viscera Entirely or Almost Entirely Covered.

Stomach,
Spleen,
Ileum,
Jejunum,
Colon—transverse,
Sigmoid flexure,
Rectum—upper part,
Liver,
Uterus,
Ovaries.

Viscera Without Peritoneal Investment.

Bladder—except posterior wall;
Rectum—lower third;
Vagina—lower part of posterior wall;
Pancreas;
Suprarenal capsules; } partly covered anteriorly.
Kidneys.

THE STOMACH.

The stomach is a musculo-membranous sac, pyriform in shape, situated below the diaphragm in an oblique position across the upper abdomen, where it is held in position by the lesser omentum and the gastro-splenic ligament. It measures about nine to twelve inches long, four to five inches in its greatest diameter, and has a capacity of from one to two quarts. It occupies the epigastric, right and left hypochondriac regions, and is in relation above with the diaphragm and liver, below with the transverse colon, in front with the abdominal walls, and behind with the pancreas. When distended the stomach rotates on its long axis and the greater curvature points somewhat forward. It presents for examination a greater and lesser extremity, greater and lesser curvatures, anterior and posterior surfaces, and cardiac and pyloric orifices.

The *greater extremity,* or fundus, occupies the left hypochondriac region, in contact with the spleen, with which it is attached by the gastro-splenic omentum, and behind the lower rib.

The *lesser* or *pyloric end* is smaller and lies in contact with the under surface of the liver and the wall of the abdomen in the right hypogastric region.

The *greater curvature* extends between the pyloric and œsophageal orifices, along the lower border of the stomach, and to it is attached the great omentum.

The *lesser curvature* extends between the same two points along the superior border of the organ.

The *œsophageal* or *cardiac orifice* occupies the highest part of the stomach, behind the left seventh costal cartilage, and receives the œsophagus.

The *pyloric orifice* occupies the right extremity, and opens into the duodenum, being protected by a muscular valve, the pylorus, or pyloric valve.

The *anterior surface* is in contact with the under surface of the left lobe of the liver, the abdominal walls, and the diaphragm.

The *posterior surface* is in contact with the peritoneum of the diaphragm, solar plexus, the pancreas, and the abdominal vessels.

The *structure* of the stomach consists of four coats, a serous, muscular, fibrous or areolar, and mucous.

The *serous coat* is derived from the peritoneum, which completely covers it, except along the lesser and greater curvature, where the vessels and nerves enter.

The *muscular coat* consists of three sets of fibres:—

The longitudinal, the most superficial, are continuous below with the longitudinal fibres of the small intestine below, and the œsophagus above;

The circular fibres, the second layer, are most abundant at the pyloric extremity, where they form the pyloric valve;

The oblique fibres are distributed over both surfaces, passing obliquely from right to left and left to right.

The *areolar* or *submucous coat* connects the muscular with the mucous layer, and is sometimes named the vascular coat.

The *mucous membrane* is of a pale pinkish-ash color, thickened toward the pylorus, where it presents numerous rugæ, or pleats, and at the pyloric end it helps to form the pyloric valve. It is lined throughout with columnar epithelium, and is studded with three kinds of minute tubes, the gastric follicles, and lenticular glands. The gastric follicles consist of two kinds, the pyloric and the peptic glands, the former most abundant at the pyloric end and the latter distributed all over the surface of the stomach.

The *pyloric* or *mucous glands* consist each of from two to four blind tubes opening into a common duct, and lined throughout by columnar epithelium.

The *peptic glands* are similar in structure, but have a much shorter duct, and contain in addition peculiar large, spheroidal, granular *peptic cells.*

The *lenticular* or *simple solitary glands* are small masses of lymphoid tissue scattered throughout the connective-tissue framework of the stomach between the gastric follicles.

The *arteries* are derived from the gastric, pyloric, and right gastro-epiploic branches of the hepatic artery, and the left gastro-epiploic and vasa brevia branches of the splenic artery (*vide* Arterial System).

The *veins* terminate in the portal, superior mesenteric, and splenic veins.

The *nerves* are derived from the gastric plexuses (Auerbach's and Meissner's, in the muscular and submucous coats, respectively), formed by the terminal branches of the right and left pneumogastric, and the branches of the cœliac plexus, an offshoot of the solar plexus of the sympathetic.

THE SMALL INTESTINE.

The small intestine is a convoluted tube about twenty to twenty-five feet in length, for the chylification of the food, occupying the lower and central portions of the abdominal and pelvic cavities, and held in position to the spinal column by the mesentery. It is divided into three portions—the duodenum, jejunum, and ileum.

THE DUODENUM, so called from being about twelve fingers' breadth in length, is about eight to ten inches in length. It consists of four portions, from the position of its course—ascending, descending, transverse, and terminal ascending:—

The *first* or *ascending portion* is about two inches in length, and ascends to the neck of the gall-bladder. It is completely invested by peritoneum for about an inch.

The *second* or *descending portion,* about three inches in length, descends in front of the right kidney as far as the third or fourth lumbar vertebra, and is overlapped in front by the head of the pancreas, and into its posterior aspect the duct of the pancreas and the common biliary duct open by a common orifice.

The *third* or *transverse portion* is attached to the crura of the diaphragm and the vessels in front of the vertebral column, passes behind the transverse mesocolon, and has the pancreas above it, and the superior mesenteric blood-vessels cross from beneath the latter between the two or over the duodenum.

The *fourth* or *terminal ascending portion* runs upward and forward to the duodeno-jejunal flexure.

The *arteries* are derived from the inferior pancreatico-duodenal branch of the superior mesenteric and the superior pancreatico-duodenal branch of the gastro-duodenal, a branch of the hepatic. The *veins* terminate in the superior mesenteric and splenic veins. The *nerves* are from the solar plexus.

THE JEJUNUM, named from *jejunus,* empty, includes the upper two-fifths of the small intestine, is continuous above with the duodenum and below with the ileum. It occupies chiefly the left iliac and umbilical region.

THE ILEUM, so called from its twisted condition, includes the remaining three-fifths, is continuous above with the jejunum and below with the caput cæcum of the large intestine. It occupies the right iliac, hypogastric, and umbilical regions.

The *structure* of the small intestine consists of four coats—the serous, muscular, fibrous or areolar, and mucous:—

The *serous coat* is the peritoneal covering;

The *muscular coat* consists of two sets—a longitudinal and a circular;

The *areolar* or *submucous coat* connects the muscular with the mucous coat;

The *mucous coat* is thinner and redder than that of the stomach, and is thrown into numerous transverse folds—the valvulæ conniventes—most numerous in the upper part; they diminish as it descends and finally disappear in the ileum. They increase the secreting and absorbing surface of the mucous membrane and retard the passage of the food.

The *mucous membrane* also contains the villi and four kinds of glands:—

Simple follicles, or crypts of Lieberkühn;
Duodenal glands, or Brunner's glands;
Solitary glands;
Agminate, or Peyer's glands.

The *villi* are minute vascular projections of the mucous membrane scattered throughout the surface of the small intestine. Their structure consists of a pouchlike termination of a lacteal in the centre surrounded by a minute plexus of capillary vessels inclosed in a basement membrane and covered with columnar epithelium.

The *simple follicles,* or *crypts of Lieberkühn,* are scattered throughout the mucous membrane of the entire small intestine. They consist of minute tubes of basement membrane, lined with columnar epithelium and surrounded by a capillary net-work.

The *duodenal* or *Brunner's glands* are distributed to the duodenum and jejunum only. They are largest and most numerous in the vicinity of the pylorus. They are composed of tubular alveoli, lined by epithelium, and having a small duct opening on the mucous membrane.

The *solitary glands* are distributed throughout the small intestine, being most numerous in the last portion of the ileum. They consist of lymph follicles, and communicate with the lacteal system by means of lymph spaces.

Peyer's glands, or *Peyer's patches,* consist of an aggregation of the solitary glands into oval groups of twenty or thirty along the small intestine at a point opposite the attachment of the mesentery. The patches are about fifteen to thirty in number, each measuring about one-half to two inches in length and one-half inch in breadth. Their axes are parallel with the length of the intestine. In the duodenum they are few and small in size, and the mucous membrane of the valvulæ conniventes over them is reduced in size and much distorted.

The *arteries* are derived from the pyloric, pancreaticoduodenal, and superior mesenteric. They reach the intestines

inclosed in and along the course of the mesenteries. In the intervals of the coats they form three vascular nets, which supply the serous, muscular, and mucous coats. The *veins* accompany the arteries and join the portal vein.

The *lymphatics* follow the course of the superior mesenteric vessels to enter the mesenteric glands.

The *nerves* are derived from the solar plexus of the sympathetic.

THE LARGE INTESTINE.

The large intestine is about five feet long and extends from the ileum to the anus.

It commences in the right iliac fossa, ascends through the right lumbar and right hypochondriac regions, passes transversely between the epigastric and umbilical regions to the left hypochondriac region, where it descends through the left hypochondriac, lumbar, and iliac regions, and through the pelvis on its posterior wall to terminate at the anus.

It consists of three divisions:—

1. Cæcum,
2. Colon, { Ascending, Transverse, Descending, Sigmoid flexure.
3. Rectum.

THE CÆCUM is a blind pouch measuring about two and one-half inches in every diameter, lying free in the right iliac region.

It has opening into its lower back part the appendix vermiformis, and into its inner back part the ileum, guarded by the ileo-cæcal valve.

The *appendix vermiformis* is a long, narrow, twisted tube, the rudiment of the prolonged cæcum in all mammalia. It terminates in a blunt extremity. Its mucous membrane is continuous with that of the cæcum, and contains many solitary glands.

The *ileo-cæcal valve,* or valve of Bauhin, protects the opening of the ileum into the cæcum, and consists of two valve-like semilunar folds of mucous membrane, strengthened by bands of circular fibres. The upper one is attached to the junction of the ileum with the colon, the lower one to the junction of the ileum with the cæcum. On each side where the folds coalesce, a ridge of mucous membrane continuous for a short distance around the canal, forming the *frœna* or *retinacula* of the valve. The mucous membrane on either side of the valves corresponds

to that of the large and small intestines respectively, being covered with villi on the side toward the ileum, and being destitute of villi, and containing numerous tubular glands or crypts of Lieberkühn, on the side toward the cæcum. This difference occurs abruptly at the free margin of the valves.

THE COLON consists of four portions—ascending, transverse, and descending colon, and sigmoid flexure:—

The *ascending* portion begins opposite the ileo-cæcal valve, ascends through the right lumbar and hypochondriac regions, and terminates beneath the under surface of the liver at the *hepatic flexure* in the transverse portion. Its posterior surface is destitute of peritoneum, and is attached to the quadratus lumborum muscle by loose areolar tissue.

The *transverse* portion, or *transverse arch of the colon,* passes from the hepatic flexure, through the adjoining portions of the epigastric and umbilical regions, to terminate at the *splenic flexure* in the descending portion. It is attached by the transverse mesocolon, and is the most movable portion of the colon.

The *descending portion* begins at the splenic flexure, descends through the left lumbar and iliac regions to terminate in the sigmoid flexure. Like the ascending colon, its posterior surface is destitute of peritoneum.

The *sigmoid flexure* (omega loop) is a narrow, twisted portion of the colon, occupying the left iliac fossa, between the descending portion of the colon and the rectum. It is held in position by the *sigmoid mesocolon.*

THE RECTUM—the terminal portion—extends from the sigmoid flexure to the anus. It is from six to eight inches in length, not sacculated, but club-shaped, with its large extremity downward, and consists of three portions—the upper, middle, and lower:—

The *upper portion,* about four inches in length, rests upon the sacral plexus of nerves and the pyriformis muscle;

The *middle portion,* about three inches, is in relation in the male with the bladder, prostate gland, and vesiculæ seminalis; in the female with the uterus and vagina, being adherent to the latter;

The *lower portion,* about one and one-quarter inches, turns backward and terminates in the anus. It is supported by the levator ani muscle, and is surrounded by the internal and external sphincters of the anus.

The *structure* of the large intestine consists of four coats—serous, muscular, cellular, and mucous:—

The *serous coat,* derived from the peritoneum, invests completely the transverse portion and upper portion of the rectum,

but only partially the others, being absent in the posterior surfaces of the ascending and descending portions, and on the middle portion of the rectum. The lower portion of the rectum is without peritoneal covering. The *appendices epiploicæ* are folds of serous membrane filled with fat and attached chiefly to the transverse colon, depending from it.

The *muscular coat* consists of longitudinal fibres arranged into three flat bands, shorter by nearly one-half than the intestine itself, and the *circular,* distributed more evenly, but accumulated at points, producing with the former a sacculated condition.

The *cellular coat* connects the mucous with the muscular coat beneath.

The *mucous coat* is smooth, destitute of villi and valvulæ conniventes, and thrown into numerous folds, two to four of which, situated in the rectum, have received the name of *Houston's folds.*

It contains crypts of Lieberkühn, more numerous here than in the small intestine, and solitary glands scattered throughout, but most numerous in the appendix and cæcum, where some of them are accumulated into Peyer's patches.

The *arteries* of the cæcum and colon are from the mesenteric. The *lymphatics* empty into the mesenteric glands, and the *nerves* are derived from the mesenteric plexus of the sympathetic system.

The *arteries* of the rectum are the hæmorrhoidal branches of the inferior mesenteric, internal iliac, and internal pudic. The *veins* form the hæmorrhoidal plexus, and empty into the inferior mesenteric and internal iliac veins.

The *lymphatics* go to the sacral and lumbar glands, and the nerves are from the hypogastric plexus of sympathetic and contiguous spinal nerves.

THE PANCREAS.

The pancreas is an oblong compound racemose gland, about six to eight inches in length, one and one-half inches in breadth, and one-half to one inch in thickness, situated across the back part of the epigastric and left hypochondriac regions. Its weight varies from two to six ounces.

It consists of a head, body, and tail:—

The *head,* or *right extremity,* is received into the concavity of the duodenum. The *lesser pancreas,* a detached portion of the gland, lies behind it.

The *tail,* or *lesser end,* terminates above the left kidney and suprarenal capsule, in contact with the spleen.

The *body* is in relation in front with the stomach and transverse mesocolon; behind it rests upon the first lumbar vertebra, having interposed the crura of the diaphragm, vena cava, left renal vein, aorta, superior mesenteric artery and vein, the inferior mesenteric vein, and commencement of portal vein.

The splenic artery and vein are lodged in a groove on its upper border.

The *pancreatic duct,* or *canal of Wirsung,* runs throughout the substance of the organ, to emerge at the head, and open into the duodenum by an orifice in common with the ductus communis choledochus. The lesser pancreas, when it exists, empties by the *ductus pancreaticus minor.*

The *structure* resembles that of the salivary glands, but is softer and looser.

Arteries are from the splenic and pancreatico-duodenal branches of the hepatic and superior mesenteric.

The *veins* join the splenic or superior mesenteric.

The *nerves* are from splenic plexus of the sympathetic.

The *lymphatics* empty into the lumbar glands.

THE LIVER.

The liver is the largest gland in the body, measuring in its transverse diameter from ten to twelve inches, and its antero-posterior six to seven, and its thickest part about three inches, and weighing about from three to four pounds. It occupies the upper part of the abdominal cavity, and the right hypochondriac, epigastric, and a portion of the left hypochondriac regions. Its upper surface is convex and rests against the diaphragm and a small portion of the abdominal parietes in front. Its lower surface is in contact with the duodenum and stomach, the right kidney and suprarenal capsules, and the hepatic flexure of the colon. It is divided by the longitudinal fissure into the right and left lobes. The liver has five fissures, five lobes, five ligaments, five sets of vessels, and is inclosed in a fibrous coat, continuous at the transverse fissure with the capsule of Glisson. It is also invested by the peritoneum, except at the attachment of the coronary ligament.

Structure.—The liver is made up of lobules, which are small, granular bodies about one-fifteenth of an inch in diameter, held together by delicate connective tissue and the branches of the five sets of vessels (to be described) and nerves, the whole being inclosed in a serous and fibrous coat.

Each lobule is made up of a mass of polyhedral, nucleated cells, inclosed in a capillary plexus derived from the hepatic

artery and portal vein, and giving origin to the hepatic vein and biliary duct.

The five fissures of the liver are all situated on its under surface. They separate the five lobes from one another. They are:—

1. *Longitudinal fissure* extends from before backward, from the notch in front to the posterior border. It is sometimes called the *umbilical fissure,* and lodges the round ligament, the remains of the fœtal umbilical vein.

2. *Fissure for the ductus venosus* is the posterior portion of the longitudinal fissure, and lodges the remains of the ductus venosus of fœtal life.

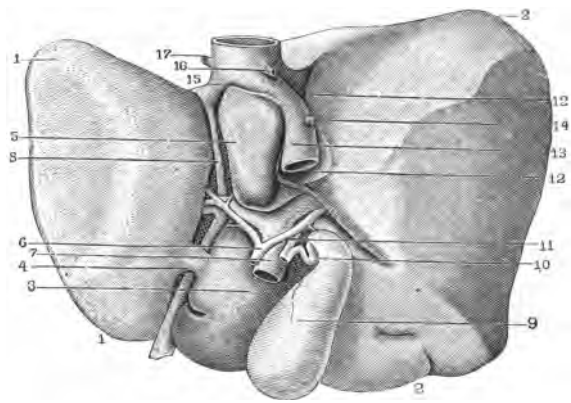


FIG. 119.

1, left lobe; 2, right lobe; 3, quadrate lobe; 4, caudate lobe; 5, Spigelian lobe; 6, hepatic artery; 7, portal vein; 8, fissure of ductus venosus; 9, gall-bladder; 10, cysti duct; 11, hepatic duct; 12, fissure for vena cava; 13, vena cava; 14, right inferior phrenic v in; 15, hepatic vein; 16, right renal vein; 17, left renal vein.

3. *Transverse fissure,* or portal fissure, crosses the inferior surface of the liver transversely and joins the longitudinal. It transmits the portal vein, hepatic artery and nerves, and the hepatic duct and lymphatics.

4. *Fissure for the gall-bladder* is a shallow depression beneath the right lobe, running parallel with the longitudinal fissure in front.

5. *Fissure for the vena cava* runs obliquely upward along the inferior surface near its posterior margin to the left side, joining the fissure for the ductus venosus behind, and separated from the transverse fissure in front by the lobulus caudatus. It lodges the inferior cava, which, within this fissure, receives the hepatic veins.

The five lobes of the liver are:—

Right lobe, much the largest, is somewhat quadrilateral in outline, and presents three fissures and two depressions, the latter one for the right kidney and its suprarenal capsule, and the other for the hepatic flexure of the colon.

Left lobe, smaller, is separated from the right lobe by the longitudinal fissure, and is in contact with the stomach.

Lobulus quadratus, or square lobe, occupies the anterior border of the under surface of the right lobe, between the umbilical fissure and the fissure for the gall-bladder, and in front of the transverse fissure.

Lobulus Spigelii occupies a similar position to the quadrate lobe, along the posterior border, immediately back of it, from

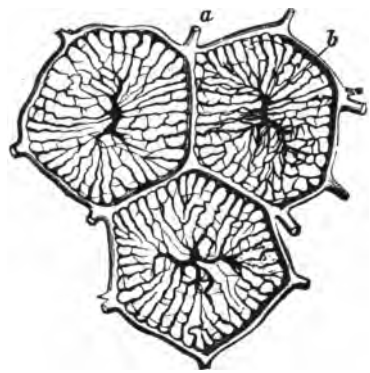


FIG. 120.

Transverse section of lobules of liver: a, interlobular vein; b, intralobular central vein.

which it is separated by the transverse fissure. It is bounded laterally by the fissures for the ductus venosus and vena cava.

Lobulus caudatus, or tailed lobe, unites the lobus Spigelii with the right lobe, and separates the transverse fissure from the fissure for the vena cava.

The five ligaments of the liver are folds of peritoneum except one, the round ligament, which is the remains of the umbilical vein and ductus venosus of the fœtus.

They are:—

1. *Longitudinal* or *falciform ligament* consists of two layers of peritoneum, attached by one margin to the under surface of the diaphragm, and the sheath of the right rectus muscle, and is attached to the liver along its anterior margin, from the notch to its posterior border.

2 and 3. The *lateral ligaments,* one on either side, are triangular layers of peritoneum, attached to the lateral edges of the liver toward its posterior margin.

4. The *coronary ligament* is formed of two layers, continuous with the lateral ligament and with the longitudinal ligament, connecting the posterior border of the liver to the diaphragm.

5. The *round ligament* is a fibrous cord, the remains of the obliterated umbilical vein and ductus venosus, extending from the umbilicus to the longitudinal fissure, extending as far back as the inferior vena cava.

The five sets of vessels are the hepatic artery, portal vein, hepatic veins, hepatic ducts, and lymphatics:—

The *hepatic artery,* the nutrient vessel of the liver, one of the branches of the cœliac axis, enters the transverse fissure, and after giving off branches to the capsule of Glisson, and to the capsule, divides into interlobular branches, which form plexuses around each lobule, and terminate in capillaries between the cells, anastomosing with the capillaries of the portal vein.

The *portal vein* enters at the transverse fissure, divides into two branches, and finally terminates in the interlobular plexuses, already described. These all unite into one vein—*intralobular vein*—traversing the centre of the lobule to join the *sublobular vein,* the latter ending in the *hepatic veins.* These latter finally terminate in the inferior vena cava.

The *hepatic ducts* originate between the hepatic cells as *bile capillaries,* minute canals without walls, and form a plexus between the lobules. From these plexuses ducts converge and unite to finally form the *hepatic duct.*

The *lymphatic vessels* form two sets—the superficial, those upon the surface of the organ; and deep, those accompanying the branches of the hepatic arteries and portal vein.

THE GALL-BLADDER is a conical membranous sac attached to the under surface of the right lobe of the liver, and partly covered by peritoneum. It measures about four inches by one, and has a capacity of about nine drachms. It consists of a fundus or rounded extremity, a body and neck, and has three coats—a fibrous, muscular, and mucous—the latter lined with columnar epithelium.

The neck terminates in the cystic duct, the mucous membrane of which is thrown into a series of folds, forming a *spiral valve.*

The *ductus communis choledochus,* or common biliary duct, about three inches long and the diameter of a goose-quill, is formed by the union of the hepatic, about two inches in length,

and the cystic, about one inch in length. It empties into the descending portion of the duodenum in common with the pancreatic duct, about three and one-half inches below the pylorus.

THE DUCTLESS GLANDS.

The following group includes the glands without ducts, of unknown function, which resemble each other in structure:—

Spleen,	Thymus,
Thyroid,	Suprarenal capsules,
Pituitary body,	Glandula coccygea,

Glandula intercarotica.

THE SPLEEN.—The spleen is a soft, very vascular, sponge-like organ, situated deeply in the left hypochondriac region. It varies much in size and weight, measuring about five inches in length, three in width, one and one-half in thickness, and weighing between seven and ten ounces.

Outer surface, smooth and convex, corresponds to the ninth, tenth, and eleventh ribs, and is adapted to the inferior surface of the diaphragm, to which it is connected by the suspensory ligament.

Inner surface is concave and adapted to the cardiac end of the stomach, to which it is attached by the gastro-splenic omentum.

Hilus is a vertical fissure on the concave inner surface, admitting the passage of blood-vessels, lymphatics, and nerves. The *structure* consists of two coats—a serous and fibro-elastic coat, inclosing in its interior the spleen pulp.

Serous coat, derived from the peritoneum, covers the entire organ, except at the hilus, where it forms the gastro-splenic omentum.

Fibro-elastic coat, or *tunica propria,* surrounds the organ, and from the hilus and periphery sends numerous fibrous bands, or *trabeculæ,* into the substance of the organ, dividing it into small *trabecular spaces,* or *areolæ.*

Splenic substance, or *spleen pulp,* is a soft, reddish-brown mass, consisting of a fine reticulum of connective-tissue corpuscles, inclosing red and white blood-corpuscles, nucleated and non-nucleated cells, granular matter, etc.

Malpighian corpuscles, or *bodies,* are spheroidal hyperplasiæ of lymphoid tissue from the outer coat of the arterioles. They are not encapsuled, vary from one-sixtieth to one-twenty-fifth of an inch, and are visible in the fresh specimens to the naked eye.

Splenic artery, remarkable for its size and tortuosity, divides in the hilus into four or five branches, each distributed to a segment, terminating in a capillary plexus without anastomoses, or opening directly into the areolæ of the splenic pulp.

Splenic vein commences in the same manner as the arterioles end, and empties into the portal vein. The smaller veins anastomose freely.

Nerves are from the splenic plexus, formed from the right pneumogastric nerve, and the left semilunar ganglion of the solar plexus.

THYROID GLAND.—The thyroid is a vascular, glandlike body, situated on the sides of the upper part of the trachea, and consists of *two lateral lobes* connected by a transverse portion, the *isthmus.*

A third lobe—the *pyramid*—sometimes arises from the left lobe or upper margin of the isthmus.

Levator glandulæ thyroideæ are muscular bands sometimes found passing from the isthmus to the body of the hyoid bone.

Structure.—This is similar to other glands, being made up of a capsule and radiating septa inclosing alveoli—the closed *vesicles*—each of which is lined with one layer of columnar epithelium, and contains more or less viscid, transparent fluid—the *colloid substance.* The closed vesicles are abundantly supplied with blood by meshes of capillaries, while penetrating the septa are lymphatic net-works, and lymph sinuses are found in the tissue between the vesicles and septa.

Arteries are the superior thyroid, a branch of external carotid, and inferior thyroid, a branch of the thyroid axis, and sometimes a branch from the arch of the aorta or innominate artery, the middle thyroid, or arteria thyroidea ima. All the vessels anastomose freely.

Veins form plexus about the gland and give off the superior and middle thyroid to internal jugular, and inferior thyroid to innominate vein.

Nerves, from middle and inferior cervical ganglia and from pneumogastric.

THYMUS GLAND.—The thymus gland is a temporary organ of unknown function which attains its full size at the end of two years and at puberty has almost disappeared. It occupies the upper part of the anterior mediastinum, and is in relation in front with the sternum, and below with the pericardium, aorta, left innominate, and trachea. It is a flat, triangular body, composed of a pair of lateral unequal lobes, about two inches in length, one and one-half inches at the widest part, and one-quarter inch thick, and weighing about one-half ounce.

Structure.—It is composed of a framework of fibro-connective tissue, consisting of a capsule and septa, and the gland substance, which is divided into lobes, these into lobules, and these into units or follicles.

The follicles vary in shape, present for study a *cortex* and *medulla,* and consist of adenoid tissue.

The cortical meshes of the reticulated adenoid tissue are filled with lymph-corpuscles, while in the medulla the meshes are less numerous and filled with large endothelioid plates and giant cells.

The capillary blood-vessels surround the follicles.

Arteries are from superior and inferior thyroid and internal mammary.

Veins join thyroid and left innominate veins.

Nerves are from sympathetic and pneumogastric.

SUPRARENAL CAPSULES.—The suprarenal capsules are two small, triangular bodies, situated upon the upper and front part of either kidney. They measure from one and one-quarter to two inches in length, and less in breadth, two to three lines in thickness, and weigh about two drachms.

Structure.—Like the kidneys, they consist of a cortical and medullary portion, inclosed in a capsule which sends septa into the substance of the body.

The *cortex* is composed of three zones of epithelial cells—outer, middle, and inner—the middle being the largest.

The *medulla* consists of streaks of small, transparent cells, separated by connective tissue and capillaries. These streaks are continuous with the inner zone of the cortex. The nerve supply is rich, consisting of non-medullated fibres connected with small ganglia.

Relations.—The inferior concave border rests upon the upper surface of the kidney. The inner border rests against the inferior vena cava on the right side, the aorta on the left, and is in relation with semilunar ganglion and great splanchnic nerves.

The anterior surfaces touch on the right the under surface of the liver and on the left side the pancreas and spleen. The posterior surface lies upon the crus of the diaphragm, about opposite the ten dorsal vertebræ.

Arteries are suprarenal from the aorta, the renal, and phrenic arteries.

Veins on the right join vena cava, on left renal vein.

Nerves, from renal and solar plexus.

PITUITARY BODY *(hypophysis cerebri)* is a small, vascular mass on the inferior surface of the cerebrum, but resembling in structure the ductless glands.

Structure.—The upper lobe is part of the central nervous system. The lower and larger lobe has a fibrous capsule which sends processes into the interior, forming minute septa; these divide and reunite around spaces called alveoli. The alveoli contain epithelial cells of various shapes, between which are small irregular cells having flattened nuclei.

THE GLANDULA COCCYGEA, lying near the tip of the coccyx and the INTERCAROTICA, at the angle of bifurcation of the common carotid, have been recently included among the ductless glands. They were both discovered by Luschka. The framework of their bodies is identical with that of other glands, except that the septa contain non-striped muscular tissue. The alveoli are filled with gland substance, consisting of connected masses of epithelial cells, having in their centre a twisted capillary blood-vessel.

VOCAL AND RESPIRATORY APPARATUS.

THE LARYNX is a musculo-cartilaginous box at the top of the trachea, below the root of the tongue and the hyoid bone, and is the organ of the voice. It is composed of cartilages connected by ligaments, provided with muscles, blood-vessels, and nerves, and lined with mucous membrane. The cartilages are nine in number, three single and three pairs:—

Thyroid,
Cricoid,
Epiglottis,
Two arytenoid,
Two cornicula laryngis,
Two cuneiform.

The *thyroid,* the largest cartilage, consists of two quadrilateral halves, united in front in the median line, or entering angle of the thyroid, the upper part of which is the pomum adami. The outer surface is marked by an oblique ridge for the attachment of muscles. The inner surface is smooth and covered by mucous membrane, and has in front attached the true and false vocal cords. The posterior angles are prolonged into superior and inferior horns, the superior giving attachment to the thyro-hyoid ligament, the inferior articulating with the sides of the cricoid cartilage.

The *cricoid cartilage* resembles a seal ring, narrow in front, the back part of the upper border articulates with the arytenoid cartilage, and on each side externally are two facets for the articulation of the inferior horns of the thyroid.

The *epiglottis* is a spoon-shaped, fibro-cartilaginous plate, large above, its narrow inferior extremity is prolonged and attached by a band of fibro-elastic tissue of thyro-epiglottic ligament to the thyroid cartilage. It is also attached to the posterior surface of the hyoid bone by the hyo-epiglottic ligament. The anterior or lingual surface has three reflections of mucous membrane between it and the tongue, called the glosso-epiglottidean ligaments.

The *arytenoid cartilages* each resembles the mouth of a pitcher, from which they are named. They are smaller than the other two, and are situated on the summit of the cricoid cartilage posteriorly. They are three-sided, the apex extends backward, and is surmounted by the *supra-arytenoid, cornicula laryngis,* or *cartilages of Santorini.*

The *posterior surface* has attached to it the arytenoid muscle. The *anterior surface* has attached to it the thyro-arytenoid muscle and the false vocal cord. The *internal surfaces* are opposed to each other and supplied with mucous membrane. Of the *three angles* at the base, the outer gives attachment to the crico-arytenoid muscle, lateral and posterior. The anterior is prolonged for attachment of the true vocal cord.

The *cuneiform cartilages,* or *cartilages of Wrisberg,* are two small rod-shaped bodies extending upward from the arytenoid cartilages into the aryteno-epiglottidean fold.

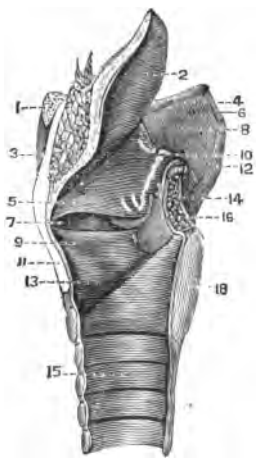


FIG. 121.

Vertical section of larynx: 1, body of hyoid bone; 2, epiglottis; 3, thyro-hyoid membrane; 4, great cornu of hyoid; 5, false vocal cord; 6, thyro-hyoid ligament; 7, ventricle of larynx; 8, thyro-hyoid membrane; 9, true vocal cord; 10, aryteno-epiglottidean fold; 11, thyroid cartilage; 12, superior cornu of thyroid; 14, arytenoid muscle; 16, arytenoid cartilage; 18, cricoid cartilage.

The cartilages of the larynx, with the exception of the epiglottis, are composed of true cartilage.

The LIGAMENTS of the LARYNX are divided into two sets—the extrinsic, those connecting the epiglottis and thyroid cartilage with the hyoid bone, and the intrinsic, those which connect the various cartilages together. The *extrinsic* consist of three:—

1. *Thyro-hyoid membrane,* connecting the upper border of the thyroid cartilage with the inner surface of the hyoid bone;

2 and 3. *The two lateral thyro-hyoid ligaments,* fibro-elastic cords connecting the superior horns of the thyroid cartilage with the extremities of the great horns of the hyoid bone. They contain a small nodule, the *cartilago-triticea.*

The *intrinsic ligaments* are sixteen in number, as follows:—

Hyo-epiglottic ligament;
Crico-thyroid membrane;
Two crico-thyroid capsular ligaments;
Two crico-arytenoid ligaments;
Two crico-arytenoid capsular ligaments;
Two superior thyro-arytenoid ligaments (in false cords);
Two inferior thyro-arytenoid ligaments (in true cords);
Thyro-epiglottic ligament;
Three glosso-epiglottic folds.

The *hyo-epiglottic ligament* is a fibro-elastic band, connecting the anterior surface of the epiglottis with the upper border of the hyoid bone. The *ligaments* connecting the cricoid to the thyroid cartilage are three also—the crico-thyroid ligament, capsular ligaments, and synovial membranes.

The *crico-thyroid membrane,* a yellow, elastic band, connects the adjacent margins of the cricoid and thyroid cartilages, and extends from the upper border of the cricoid cartilage to the lower margin of the true vocal cords.

The two *crico-thyroid capsular ligaments* surround the articulations between the inferior horns of the thyroid and the cricoid cartilage.

The *snyovial membrane* lines the capsular ligaments, forming a true enarthrodial joint.

The *ligaments* of the *epiglottis* are the *thyro-epiglottic,* the *hyo-epiglottic,* and the three *glosso-epiglottic* folds of mucous membrane before described.

The *superior aperture* of the larynx is a triangular opening with the apex in front. It is bounded behind by the apices of the arytenoid cartilages and corniculæ laryngis, in front by the epiglottis, and laterally by the aryteno-epiglottidean folds. From this, as its superior boundary, the cavity of the larynx extends as low as to the lower border of the cricoid cartilage. The true vocal cords and the thyro-arytenoid muscle divide it into two parts, the narrow fissure between the two cords being called the *glottis,* or *rima glottidis.*

The *superior* or *false vocal cords* are two folds of mucous membrane inclosing the superior thyro-arytenoid ligaments.

The *inferior* or *true vocal cords* are two folds of mucous membrane inclosing the inferior thyro-arytenoid ligaments, composed of elastic tissue, from the sides of the upper border of the cricoid cartilage, extending upward to the bases of the arytenoid cartilages, and lower portion of the angle of the thyroid. Their upper margins correspond to the lower edges of the ventricles of the larynx.

The *ventricle of the larynx* is a deep fossa on either side of the larynx, bounded above by the false vocal cords, below by the inferior or true vocal cords, and externally by the thyro-arytenoideus muscle.

The *sacculus laryngis,* or laryngeal pouch, is a membranous sac lined with mucous membrane, opening into the anterior portion of the ventricle of the larynx. Its inner or laryngeal surface is covered by the aryteno-epiglottideus inferior, and the outer side by the thyro-epiglottideus and thyro-arytenoideus muscles. It is compressed by these muscles, discharging its mucous secretion upon the true vocal cords.

MUSCLES.—The *intrinsic muscles of the larynx* consist of two sets, five connected with the vocal cords and rima glottidis, and three with the epiglottis. The *five muscles* of the *vocal cords* are:—

Crico-thyroid.—Origin, from the front and sides of the cricoid cartilage; *insertion,* into anterior border of the inferior cornua, and lower margin of the thyroid cartilage; *action,* elongates and renders tense the vocal cords; *nerve,* superior laryngeal.

Crico-arytænoideus Posticus.—Origin, from the sides and posterior surface of the cricoid cartilage; *insertion,* into the outer angle of the base of arytenoid cartilage; *action,* rotates the arytenoid cartilages outward, opening the glottis, and rendering tense the vocal cords; *nerve,* recurrent laryngeal.

Crico-arytænoideus Lateralis.—Origin, from upper and outer side of the cricoid cartilage; *insertion,* in front of the preceding into the outer angle of the base arytenoid; *action,* rotates the arytenoids inward, closing the glottis; *nerve,* recurrent laryngeal.

Arytænoideus.—Origin, from outer border and posterior surface of one arytenoid cartilage; *insertion,* into the same part of the other—its fibres are oblique and transverse; *action,* by approximating the arytenoids closes the back part of the glottis; *nerves,* superior and recurrent laryngeal.

Thyro-arytænoideus.—Origin, from the crico-thyroid membrane and lower half of the entering angle of the thyroid cartilage; *insertion,* into anterior surface and base of the arytenoid cartilage—it consists of inferior and superior portions, the former entering into the formation of the true vocal cords; *action,* mainly relaxes the true vocal cords by drawing the arytenoids forward; *nerve,* recurrent laryngeal.

The muscles of the epiglottis are:—

Thyro-epiglottideus.—Origin, from the inner surface of thyroid cartilage; *insertion,* into the margin of epiglottis and

aryteno-epiglottidean fold; *action,* compress the sacculus laryngis and depress the epiglottis; *nerve,* recurrent laryngeal.

Arytæno-epiglottideus superior.—Origin, from apex of arytenoid; *insertion,* into aryteno-epiglottidean folds; *action,* constricts the superior laryngeal aperture; *nerve,* recurrent laryngeal.

Arytæno-epiglottideus inferior.—Origin, from middle of internal portion of the arytenoid; *insertion,* into upper and inner part of epiglottis; *action,* compresses the sacculus laryngis; *nerve,* recurrent laryngeal.

The lining *mucous membrane* of the larynx is continuous with that of the pharynx and trachea. It forms the glosso-epiglottic and arytæno-epiglottic folds, adheres tightly to the epiglottis, vocal cords, and the interior of the cricoid cartilage, but is more loosely attached to other parts. It contains numerous racemose glands, particularly along the posterior margin of the arytæno-epiglottidean fold, and in front of the arytenoid cartilages, where they are called the *arytenoid glands.* Its epithelium is of the ciliated, columnar variety below the true vocal cords, and above this point in front as high as the middle of the epiglottis. The other portions are covered by squamous epithelium.

The *arteries* are the laryngeal branches from the superior and inferior thyroid, and the crico-thyroid branches of the superior thyroid.

The *veins* join the inferior, middle, and superior thyroid veins.

The *lymphatics* enter the deep cervical glands.

The *nerves* are the inferior or recurrent laryngeal, the superior laryngeal branches of the pneumogastric, and branches from the sympathetic nerve.

The *superior laryngeal* supplies sensation to the larynx. It descends from the inferior ganglion of the pneumogastric, behind the internal carotid at the side of the pharynx, and divides into two branches—the *internal laryngeal* pierces the thyro-hyoid membrane to supply the mucous membrane and arytenoid muscle, the *external laryngeal* supplies the crico-thyroid muscle.

The *inferior* or *recurrent laryngeal,* from its origin, winds around the subclavian on the right side and around the arch of the aorta on the left side, and ascends by the side of the trachea to the larynx, of which it is the motor nerve, supplying all the muscles of the larynx except the crico-thyroid, giving off in its course cardiac, œsophageal, tracheal, and pharyngeal branches, and anastomosing with the superior laryngeal nerve.

TRACHEA AND BRONCHI.

The *trachea,* or *windpipe,* is a membrano-cartilaginous tube, about four and a half inches in length, three-quarters to one inch in width, extending from the fifth cervical to the upper border of the fifth dorsal vertebra. It divides into two bronchi, the right, about an inch long and nearly at right angles, passing behind the right pulmonary artery on a level with the fifth dorsal vertebra; the left, narrower, about twice as long, passes beneath the arch of the aorta on a level with the fifth or sixth dorsal vertebra, behind the left pulmonary artery. The trachea and bronchi are formed of a series of cartilaginous rings, incomplete at their posterior third, connected by fibro-elastic membrane, and lined by columnar ciliated epithelium. The last ring is triangular, so as to fit the rings of the two bronchi. The mucous membrane contains numerous racemose glands, the largest on the posterior surface, called the tracheal glands. The muscular fibres consist of two layers, longitudinal, the most external and transverse internal, both unstriated.

Relations.—The trachea has the following relations in the neck:—

Laterally.

Lobes of the thyroid body;
Carotid arteries;
Inferior thyroid arteries.

Anteriorly.

Skin, superficial and deep fascia;
Anterior jugular veins;
Left innominate vein;
Inferior thyroid plexus of veins;
Isthmus of thyroid body;
Arteria thyroidea ima (sometimes).

Posteriorly.

Œsophagus;
Vertebral column;
Recurrent and inferior laryngeal nerves.

The following in the thorax:—

Laterally.

Pleura;
Pneumogastric nerves.

Anteriorly.

Sternum;
Remains of thymus;
Arch of aorta;
Right and left innominate veins;
Left carotid artery;
Deep cardiac plexus.

Posteriorly.

Œsophagus.

The *arteries* are derived from the inferior thyroid and bronchial.

The *veins* empty into the thyroid and bronchial plexuses.

The *nerves* are from the pneumogastric and sympathetic.

The *lymphatics* empty into the mediastinal glands.

The bronchi are the continuation of the trachea from its bifurcation to the hilus of the lung.

Right bronchus is shorter, about one inch in length, placed more horizontally, and wider. It divides at the hilus into three short branches, corresponding to the divisions of the right lung.

Left bronchus is longer, nearly two inches in length, placed more obliquely, and narrower than the right. It divides into two long branches corresponding to the number of lobes:—

Relations.—The right bronchus has the right auricle and the superior vena cava in front of it, the right pulmonary artery at first below, then passing also in front, and the vena azygos arching over it from behind;

The left bronchus has the arch of aorta above, the left pulmonary artery at first above, then in front, and the œsophagus, thoracic duct and descending aorta behind.

The *arteries, veins, nerves,* and *lymphatics* are the same as for the trachea.

The two bronchi subdivide into the bronchial tubes, or bronchioles, which ramify throughout the lungs, dividing and subdividing, to end finally in the primary lobules, where they communicate with the intercellular air-passages. Their cartilages consist of thin plates, distributed irregularly along the tubes, and in the finer tubes disappearing entirely. The mucous membrane of the bronchi and bronchial tubes is lined throughout with columnar ciliated epithelium.

THE LUNGS.

The lungs, the organs of respiration, are two in number, occupying the lateral cavities of the chest, separated from each other by the heart and structures within the mediastinum. They

accurately fill the cavity of the chest at all times, and are covered by the pleura. They are conical in shape, presenting each a base, apex, two borders, and two surfaces. The *apex* extends upward above the level of the first rib; the *base* occupies the convex surface of the diaphragm; the *external,* or *thoracic surface* is accurately applied to the wall of the thorax; the *inner surface* is in contact with the pericardium, and is marked by a depression, the *hilum pulmonis,* at the root of the lungs. The *posterior border* rests on either side of the spinal column, and the *anterior border* is thin and overlaps the pericardium.

The *root* of each *lung,* situated near its middle, is composed of the following structures, surrounded by a reflection of pleura:—

Bronchus;
Pulmonary artery;
Pulmonary veins;
Bronchial glands;
Bronchial vessels;
Posterior and anterior pulmonary plexuses of nerves;
Connective tissue.

The root of the right lung is behind the right superior cava and the vena azygos arches over it. The root of the left lung lies below and in front of the arch and descending aorta. The relative positions of the pulmonary veins, pulmonary artery, and bronchus on either side are:—

Both sides, from before backward—

V. Pulmonary veins,
A. Pulmonary artery,
B. Bronchus.

Right side, from above downward—

B. Bronchus,
A. Pulmonary artery,
V. Pulmonary veins.

Left side, from above downward—

A. Pulmonary artery,
B. Bronchus,
V. Pulmonary veins.

The weight of the lungs varies according to many conditions. In the adult the approximate weight is about forty-two ounces, the right being two ounces heavier than the left, and their total capacity about three hundred cubic inches. The right lung has three lobes, the left but two, of which the lower is the larger.

The lungs in infancy are of a pale-rose color, but later become of a leaden hue, variegated with dark slate and bluish-black. They are highly elastic, crackle on pressure, and float in water, having a specific gravity of 0.345 to 0.746. In the fœtus before birth, and also in certain diseases, they sink in water. The *structure* of the lung consists of an external serous coat, the visceral layer of the pleura, a subserous areolar tissue, highly elastic, and the parenchyma, or proper substance of the lungs. The latter is made up of small polyhedral primary lobules, which unite to

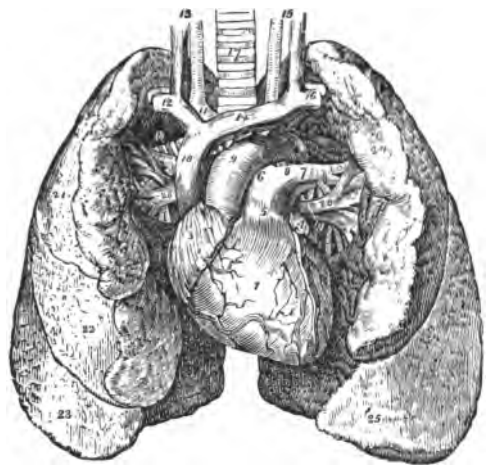


FIG. 122.

Heart and lungs: 1, right ventricle; 3, right auricle; 5, pulmonary artery; 9, aorta; 10, superior cava; 20, root of lung; 21, 22, 23, upper, middle, and lower lobes of right lung; 24, 25, upper and lower lobes of left lung.

form secondary lobules, the latter giving rise to the markings on the surface. Both the primary and secondary lobules are held together by connective tissue. A primary lobule represents the structure of the entire organ, consisting of a *bronchiole* and *infundibula,* or air-passage, communicating with numerous air-cells.

The *air-cells* are minute polyhedral cavities, from one two-hundredths to one-seventieth of an inch in diameter, separated from each other by a thin lamina, and communicating freely with the infundibula. They vary much in size, being largest on the surface, the thin borders, and the apices. Each air-cell is composed of the basement membrane, lined with squamous epi-

thelium, and surrounded by a minute capillary net-work of blood-vessels, which intervene between the terminal branches of the pulmonary artery and the commencement of the pulmonary veins. Between the cells the capillary net-work forms a single layer.

The *pulmonary artery* conveys the venous blood to the lungs and terminates in the capillary net-work about the air-cells, from which proceeds the *pulmonary vein,* which proceeds along the bronchial tubes to the left auricle of the heart. The *bronchial arteries* supply the structure of the lungs. They are derived from the aorta, and follow the course of the bronchial tubes, the *bronchial veins* returning the blood to terminate in the hemi-azygos or superior intercostal vein on the left.

The *lymphatics* are numerous and consist of a superficial set converging to the root and a deep set along the course of the tubes, and both enter the bronchial glands.

The *nerves* are derived from the anterior and posterior pulmonary plexuses of the pneumogastric and sympathetic, the latter the larger. Ganglia are found upon these nerves.

THE PLEURÆ.

Each lung is invested by a delicate serous membrane, the pleura, which lines the internal wall of the thorax and is reflected at the root of the lung over that organ. It consists essentially of two layers, a *parietal,* or pleura costalis, and *visceral,* or pleura pulmonalis. It adheres accurately to the subjacent structures, and is called, from its position, costal, diaphramatic, mediastinal, and pulmonary. The space between the two layers of each pleura, known as the *cavity of the pleura,* contains a thin, serous secretion.

A fold extending downward from the root of the lung to the diaphragm forms the so-called pulmonary ligament, or *ligamentum latum pulmonis.*

Each pleura is a closed sac; the right is wider, shorter, and extends higher in the neck than the left. They do not meet in the median line, except opposite the upper part of the gladiolus, but have a space between them known as the mediastinum.

The *arteries* are from the intercostal, bronchial, pericardiac, internal mammary, musculo-phrenic, and thymic.

The *veins* accompany the arteries.

The *lymphatics* are numerous, and empty into the intercostal and posterior mediastinal glands.

The *nerves* are from the phrenic and sympathetic.

MEDIASTINUM.

The mediastinum is the space left between the two pleuræ in the median line between the sternum and vertebral column, and contains the heart within its pericardium and all the thoracic viscera except the lungs. The intervals in the mediastinum from their position are named anterior, middle, posterior, and superior mediastinal cavities. The boundaries and contents of the four mediastinal cavities are as follow:—

Anterior mediastinum, bounded in front by the sternum; laterally, pleura; behind, the pericardium. It contains:—

Triangularis sterni muscle;
Remains of thymus gland;
Left internal mammary artery and venæ comites;
Lymphatic vessels from convex surface of the liver;
Areolar connective tissue.

Middle mediastinum, bounded in front by the anterior mediastinum; laterally, by the pleura; behind, posterior mediastinum. It contains:—

Ascending portion of aorta;
Superior vena cava;
Heart, inclosed in the pericardium;
Bifurcation of trachea;
Pulmonary artery and veins;
Phrenic nerves;
Arteriæ comites nervi phrenici, from the internal mammary.

Posterior mediastinum, bounded in front by the pericardium and root of the lungs; behind, vertebral column; laterally pleura. It contains:—

Œsophagus;
Thoracic duct;
Descending aorta;
Lymphatic glands and vessels;
Vena azygos major;
Vena azygos minor;
Superior intercostal veins;
Pneumogastric nerves;
Great splanchnic nerves.

The *superior mediastinum* is that portion of the mediastinal space above the upper border of the fifth thoracic vertebra. It is bounded in front by the manubrium sterni; behind, by the upper dorsal vertebra; laterally, by the pleura. It contains:—

Origin of sterno-thyroid muscle;
Origin of sterno-hyoid muscle;
Lower end of the longus colli muscle;
Innominate artery;
Left carotid artery;
Subclavian artery;
Transverse portion of the aorta;
Innominate veins;
Superior vena cava;
Left superior intercostal vein;
Left recurrent laryngeal nerves;
Cardiac nerves;
Pneumogastric nerves;
Phrenic nerves;
Œsophagus;
Trachea;
Thoracic duct;
Remains of the thymus gland;
Lymphatics.

THE GENITO-URINARY APPARATUS.

THE genito-urinary apparatus consists of the urinary organs and the male and female generative organs.

THE URINARY ORGANS.

The urinary organs consist of the kidneys, ureters, bladder, and urethra.

THE KIDNEYS are two glandular organs, situated deeply in the lumbar region, opposite the second or third lumbar vertebra and last dorsal, the right a little lower than the left. They are surrounded by fat and held in position by the blood-vessels and loose connective tissue. The right kidney is in relation in front with the liver, descending portion of the duodenum and ascending colon. The left is in relation with cardiac end of stomach, lower end of spleen, tail of pancreas, and descending colon. Each kidney measures about four inches in length, two in width, and one in thickness, and weighs from four and one-half to six ounces in male, four to five and one-half in female. Their shape is characteristic. The notch at the inner side is called the *hilus,* and communicates with the interior cavity, the sinus, at which the blood-vessels, nerves, and ureter have their passage. The kidneys have a special fibrous coat, slightly adherent, which extends into the hilus and becomes continuous with the fibrous coat of the blood-vessels and ureters. The relative position of the arteries, veins, and ureter at the hilus are, from above downward:—

A. Artery,
V. Vein,
U. Ureter;

from before backward:—

V. Vein,
A. Artery,
U. Ureter.

The general *structure* of the kidney consists of a cortical substance and a medullary substance, the latter arranged into conical masses called renal pyramids, with their bases in the cortical substance, and their apices, the renal papillæ, projecting

into the calices of the pelvis within the sinus of the kidney. The renal *pyramids* of *Malpighi,* about ten to fifteen in number, corresponding to the fœtal lobules, are arranged into three irregular rows. The substance, or parenchyma of the kidney, is composed of uriniferous tubules, held together by comparatively little

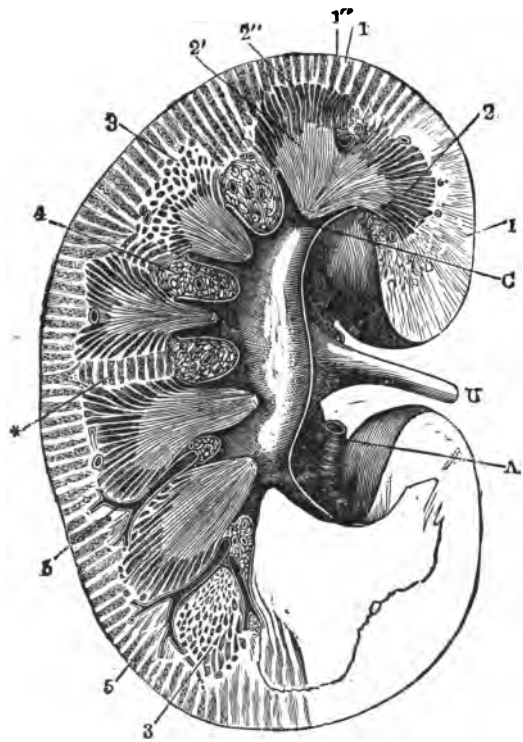


FIG. 123.

Longitudinal section of kidney: 1, cortex; 2, medulla; 3, section of tubules in boundary layer; 4, fat of renal sinus; 5, renal arteriole; A, branch of renal artery; C, renal calyx; U, ureter.

connective tissue. The terminal orifices of these, several hundred to each papilla, open on its summit.

Course of the Tubuli Uriniferi.—Beginning at the Malpighian capsule within the cortex, each tubule pursues a very tortuous and complicated course before it terminates in the renal papillæ, the outline of which is as follows (after Gray) :—

(a) Neck—the constricted portion below the capsule, before it terminates in the renal papillæ,

(b) Proximal convoluted tube, } Within the cortical structure.
(c) Spiral tubule of Schachowa, }

(d) Descending limb of Henle's loop, } Within the medullary structure.
(e) Henle's loop, }

(f) Ascending limb of Henle's loop,
(g) Irregular tubule,
(h) Distal convoluted tubule, } Cortical structure.
(i) Curved tubule,

(j) Straight collecting tubule—descends through the medullary structure to open by an orifice in a renal papilla.

The *straight, collecting* or *receiving* tubes converge as they descend, and unite and reunite until there are about one dozen, but they vary from eight to twenty, one opening on the summit of each papilla. In the cortical portion they form groups, or *medullary rays,* giving the appearance of conical masses in the cortical substance with their bases toward the periphery—the so-called *pyramids of Ferrein.* The tubules are composed of a basement membrane, lined with pavement epithelium. In the neck the epithelium becomes continuous with that of the Malpighian capsule, and at the glomerule the wall is reflected upon the inclosed tuft, or Malpighian corpuscle. In other situations the epithelium varies much in shape and size. The *renal arteries* subdivide at the hilum, cross the sinus, and enter the renal substance between the renal papillæ. They terminate in the renal glomerules, or Malpighian corpuscles. Each one of these remarkable convolutions of capillaries is about one one-hundredth of an inch in diameter and inclosed in a pouch-like dilatation of the uriniferous tubules or Malpighian capsule, or capsule of Bowman. The efferent vessels form, together with others, a capillary net-work between and around the uriniferous tubules. They are made up of *three sets: (a)* the plexuses around the tubuli contorti; *(b)* the veins beneath the capsule; and *(c)* the plexuses about the apices of the pyramids of Malpighi. These form the *venæ interlobulares,* which join the *venæ rectæ,* and together form the renal veins, *venæ propriæ renales.* Those in the sinus unite together to form the renal vein, and open into the inferior vena cava, the left crossing in front of the abdominal aorta.

The *ureter* commences as a compressed pouch, the pelvis. Within the sinus the pelvis divides and subdivides into several small funnels, or *calices,* each one of which receives one or two projecting renal papillæ. The *calices,* pelvis, and ureter are all of the same structure, consisting of a fibrous and unstriated muscular and a mucous coat. The fibrous coat becomes continuous with the capsule above and below in the fibrous structure of the

bladder. The muscular coat ceases at the base of the renal papillæ, but the mucous membrane becomes continuous with that of the uriniferous tubules. Its epithelium is of the "transi-

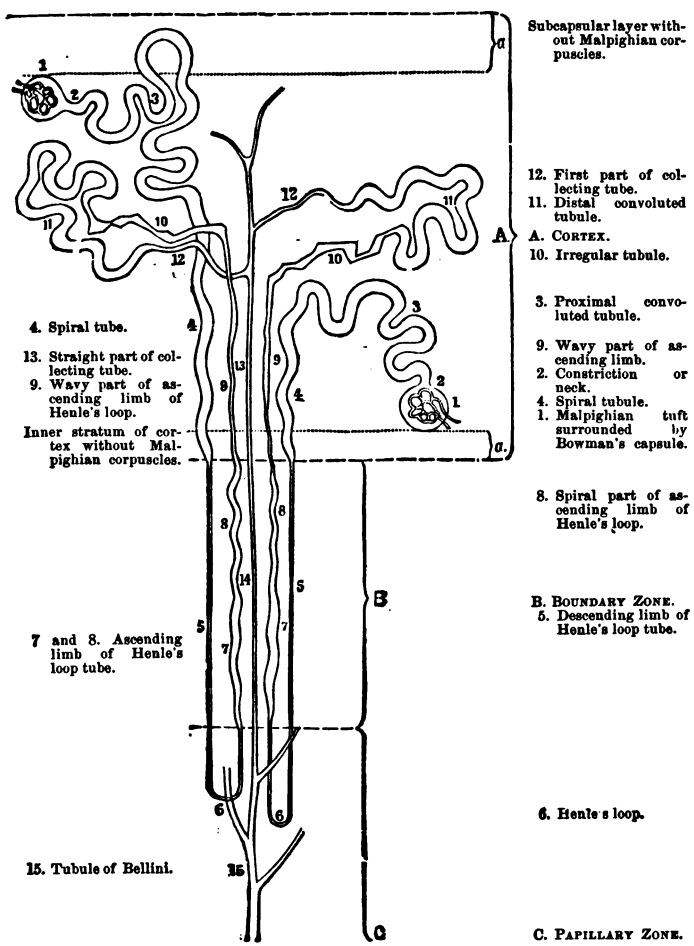


Fig. 124.

Diagram of uriniferous tubules: 1, Malpighian capsule; 2, proximal convoluted tubule; 2 b, distal convoluted tubule; 3, descending limb of Henle's loop; 4, ascending limb of Henle's loop; 5, irregular tubule; 6, collecting tube; a, apex of pyramid; b, base of pyramid; c, cortical portion.

tional" variety, consisting of several layers of cells of varying shapes, resting upon a basement membrane.

The *nerves* are derived from the renal plexus of the sympathetic, formed by branches in the semilunar ganglion, the solar plexus, and the lesser and smallest splanchnic nerve.

The *lymphatics* communicate with the lumbar glands.

The *ureter proper* is a musculo-membranous tube, sixteen to eighteen inches in length, about the diameter of a goose-quill, extending from its origin in the pelvis of the kidney to the basal or posterior angle of the vesical trigone, which it enters by passing obliquely through the muscular and mucous walls of the bladder.

Course.—It descends upon the psoas magnus muscle, beneath the peritoneum, being crossed by the spermatic vessels. About the first division of the sacrum it crosses the external or common iliac artery, passing behind the sigmoid flexure on the left and the ileum on the right side, to enter the pelvis, where it reaches the bladder within its posterior false ligament.

In the male it passes behind the vas deferens.

In the female it crosses the uterine artery $^1/_3$ to $^1/_2$ inch from the cervix uteri and passes along the side and upper part of the vagina to the bladder (*vide* Vagina).

Muscles of the Ureters.—Two oblique muscles. *Origin,* behind the orifices of the ureters; *insertion,* into the middle lobe of the prostate gland; *action,* they guard the orifices of the ureters, and prevent the reflux of urine.

SUPRARENAL CAPSULES (*vide* Ductless Glands).

THE BLADDER.

The bladder is a musculo-membranous sac, the reservoir for the urine, situated in the anterior part of the pelvis, behind the pubes, in front of the uterus and vagina in the female, and the rectum in the male.

It measures, moderately distended, five inches in length, three in width, and holds about one pint. It consists of a body, summit, base, and neck.

The *body* is partially invested with peritoneum behind, but in front it is wanting, the body being in relation with the symphysis pubis, triangular ligament, and internal obturator muscles.

The *summit,* or *apex,* is rounded, and directed upward and forward, being connected to the umbilicus by the *urachus,* the remains of the fœtal allantois, and also by the obliterated hypogastric arteries, one on either side.

The space bounded by the pubic surface and the sides of the bladder uncovered by peritoneum, filled by the recto-vesical fascia, is known as the space of Retzius.

The *base,* or *fundus,* in the male is situated upon a triangular space upon the second portion of the rectum, its base formed behind by the recto-vesical fold, its apex by the prostate gland, and its sides by the vas deferens and vesiculæ seminales.

In the female it is situated in contact with the cervix uteri and anterior wall of the vagina, adhering closely to the latter. Its upper portion has a peritoneal covering.

The *neck,* or *cervix,* is the contracted portion, continuous with the urethra. It is encircled in the male by the prostate gland, and is directed in both obliquely forward and downward.

The *ligaments* of the *bladder* consist of five true ligaments derived from the pelvic fascia and the urachus; and five false ligaments derived from the peritoneum.

The *true* ligaments are:—

Two anterior (pubo-prostatic), two folds of recto-vesical fascia passing from the pubic symphysis to the cervix and upper surface of prostate gland;

Two lateral folds of recto-vesical fascia connecting the lateral surfaces of prostate gland with sides of base of bladder;

The urachus, an obliterated fœtal structure, passing as a fibro-muscular cord from the apex of the bladder to the umbilicus.

The *false* ligaments are:—

Two posterior ligaments are peritoneal folds passing between sides of rectum in male, sides of uterus in female, to postero-lateral surface of bladder, inclosing obliterated hypogastric arteries, ureters, vessels, and nerves;

Two laterals are folds of peritoneum passing from iliac fossæ to sides of bladder;

The superior is a single peritoneal fold inclosing the obliterated hypogastric arteries from apex of bladder to umbilicus.

The *structure* consists of four coats, a serous, muscular, submucous, and mucous.

The *serous* coat is derived from the peritoneum. It covers the posterior surface from the ureters to the summit, and is reflected from the sides to the walls of the pelvis and abdomen.

The *muscular* coat is made up of unstriated fibres arranged into three *layers*:—

(a) Longitudinal external layer, named the *detrusor urinæ muscle;*

(b) Circular middle layer, forming at the neck the sphincter vesicæ;

(c) Longitudinal internal layer.

The *submucous* or *cellular* coat, made up of fibrous and elastic tissue, supports the mucous coat and unites it with the muscular.

The *mucous* membrane is smooth and of a pale-rose color. Its epithelium is continuous with that of the ureters and pelvis of kidneys; its superficial layer, large, tessellated, polyhedral cells, its deep layer of club-shaped and spindle-shaped cells.

The inner surface of the base presents a triangular space, the vesical trigone, or *trigonum vesicæ* apex in front, formed by the orifice of the urethra, its basal angles behind about two inches apart, and each about one and one-half inches behind the urethral orifice, formed by the orifices of the ureters:—

U
1½ 1½″
U U
2″

The *uvula vesicæ* is an elevation of mucous membrane projecting from the floor near the apex of the trigone into the orifice of the urethra.

The *arteries* are the superior, middle, and inferior vesical, with branches from the obturator and sciatic in the male, and branches from the vaginal and uterine in the female.

The *veins* from the vesico-prostatic empty into the internal iliac vein.

Lymphatics follow the course of the vessels and enter the lumbar glands.

The *nerves* to the base and neck are from the third and fourth sacral, and to the summit from the hypogastric plexus of the sympathetic.

GENERATIVE APPARATUS.

Male Organs.

The male organs of generation consist of the testes, vasa deferentia, vesiculæ seminales, and penis.

THE TESTICLES (testes) are two glandular bodies which secrete the spermatic fluid, and are suspended by the spermatic cords within the scrotum, the left a little larger and lower than the right. They are oval, compressed laterally, measure one and a half to two inches in length, one inch in breadth, one and one-fourth inches in their antero-posterior diameter, and weigh from six to eight drachms.

They each consist of a body, or testicle proper, and an *epididymis.* The latter consists of a *head, body,* and *tail.*

The scrotum consists of the skin marked in the median line by the *raphé,* formed by the union of the genital folds, and the dartos, a reddish, contractile tissue which surrounds the testes and extends from the raphé to the under surface of the penis, forming the *septum scroti,* which divides it into two cavities for the testes.

The *spermatic cord* is made up of the following structures:—

External spermatic, or intercolumnar fascia;
Cremaster muscle;
Internal spermatic fascia, or fascia propria;
Vas deferens;
Spermatic artery;
Deferential artery from superior vesicle;
Cremasteric artery, from epigastric;
Vasa spermatica;
Lymphatic vessels;
Spermatic plexus of nerves [from renal and aortic plexuses];
Genital branch of genito-crural;
Scrotal branch of the ilio-inguinal.

It commences at the internal abdominal ring, passes obliquely through the inguinal canal, emerges at the external abdominal ring, descends into the scrotum, and terminates at the posterior border of the testes.

The external spermatic or intercolumnar fascia is derived from the aponeurosis of the external oblique muscle. This muscle arises within the inguinal canal from Poupart's ligament and pubic spine, and descends along the cord in loops. Its fibres are striated.

The cremaster muscle, or cremasteric fascia or middle spermatic fascia, is derived from the lower border of the internal oblique and transversalis muscle.

The internal spermatic fascia, or fascia propria, is the infundibuliform process of the transversalis fascia.

The proper coverings or tunics of the testicle are three—tunica vaginalis, tunica albuginea, and tunica vasculosa:—

The *tunica vaginalis* is a serous membrane surrounding the testes, and at the posterior portion is reflected on itself to form a sac. The outer portion of the latter is loosely attached, except at the lower part of the testicle, where the gubernaculum testis binds it down.

The *tunica albuginea* is a dense, white, fibrous structure, continuous at the upper part with a similar structure on the epididymis. At the back part it projects into the glandular sub-

stance of the testicle to form the *mediastinum testis* (or corpus Highmorianum), from which numerous *septula* (trabeculæ)

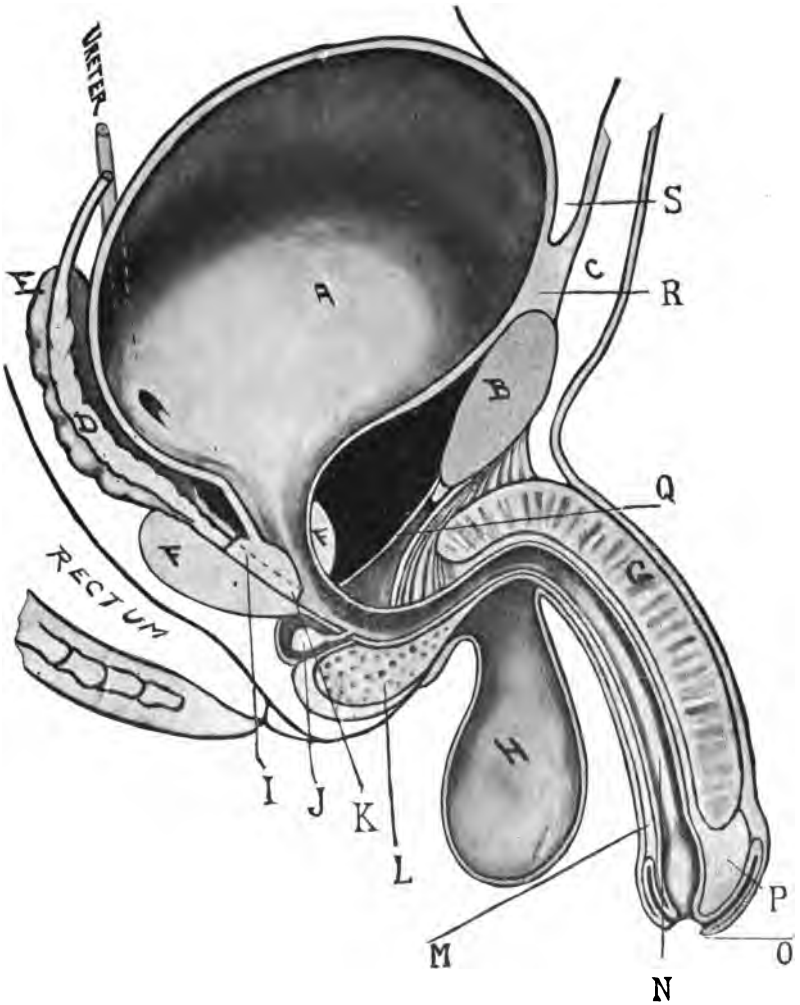


FIG. 125.

Male organs of generation: A, interior of bladder; B, symphysis pubis; C, integument; D, vas deferens; E, vesiculæ seminales; F, prostate gland; G, corpus cavernosum; H, scrotum; I, verumontanum; J, Cowper's gland; K, orifice of ejaculatory duct; L, bulb of corpus spongiosum; M, corpus spongiosum; N, urethra; O, prepuce; P, glans penis; Q, suspensory ligament; R, space of Retzius; S, peritoneal fold.

diverge, and with similar cords from the tunica albuginea serve to maintain the shape of the gland and divide it into lobules.

The *tunica vasculosa* (pia mater testis) lies within the tunica albuginea, and is the source and termination of the blood-vessels to the secretory substance of the gland, resembling the pia mater of the brain.

The *glandular structure* of the testis is divided into several hundred (two hundred and fifty to four hundred) pyramidal *lobules (lobuli testis),* each one of which consists of from one to three *tubuli seminiferi.*

At the conical extremity of the lobules the tubules end in straight tubes, *vasa recta,* which enter the mediastinum to form the *plexus retiformis.* From the upper part of this the vessels unite into from twelve to twenty *vasa efferentia,* which pass out of the testicle to the epididymis. Within the epididymis these efferent canals form a series of spermatic cones, the *coni vasculosi.* These end in a coarse, convoluted tube, about twenty feet in length, forming the body and tail of the epididymis, and ending in the spermatic duct, or *vas deferens.* These tubes are lined with columnar ciliated epithelium.

The *vas aberrans* of Haller is a spermatic cone joining the epididymis, but unconnected with the testicle.

The *hydatids of Morgagni* are one or two pediculated bodies attached to upper part of testis or head of epididymis, and supposed to be the remains of Müller's duct.

Structure of the Tubules.—The tubuli seminiferi are minute convoluted tubules, closed at one extremity, consisting of a hyaline membrana propria lined with several layers of epithelial polyhedral cells, the *seminal cells,* from which the seminal or spermatic fluid is directly elaborated.

These cells undergo a process of indirect division to form the *spermatoblasts,* which are arranged into bundles, and are converted into *spermatozoids,* the nuclei becoming the head, and the tail, or ciliary appendages, being afterward developed. These cells are constantly cast off and replaced.

Descent of the Testes.—In early fœtal life the testes are placed at the back part of the abdomen, below and in front of the kidneys, and behind the peritoneum.

About the third month a peculiar structure, the *gubernaculum testis,* appears, attached to the lower end of the epididymis, and extending as a cord to the bottom of the scrotum. It is supposed to cause the descent of the testicle. It reaches its full development between the fifth and sixth month, at which time the testicle reaches the iliac fossa. It enters the internal abdominal ring by seventh month, and the scrotum by the eighth

month, carrying before it a fold of peritoneum, which is afterward shut off, forming the *tunica vaginalis testis*. Other coverings of the testicles are also derived in this manner. In the female a structure similar to the gubernaculum forms the round ligament.

The *vas deferens* has three coats—(1) an external fibrous coat, (2) an unstriated muscular coat, and (3) a lining mem-

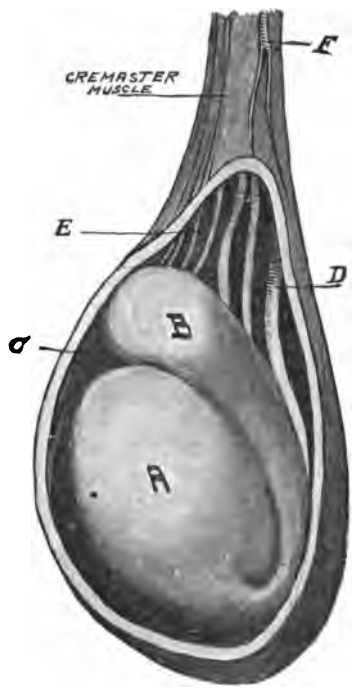


FIG. 126.

The testicle and epididymis: A, testis; B, epididymis; C, tunica vaginalis; D, vas deferens; E, spermatic artery and veins; F, artery of cord.

brane of columnar epithelium. It is about one and one-half feet long and one line in diameter. From the tail of the epididymis it ascends in the cord, forming an important part, and lying behind the blood-vessels. It ascends through the inguinal canal, and at the internal ring descends on the bladder, crosses the ureter and obliterated hypogastric artery, and runs forward to form with the duct of the seminal vesicle the ejaculatory duct.

The walls of the vas are very thick and the canal very small. Its course for the most part is straight, but beneath the bladder it becomes enlarged, tortuous, and more capacious, but again contracts near its termination.

The *arteries* of the cord are:—

The spermatic, to the testicle from the aorta;
The vas deferens, or deferent artery, from the superior vesical;
The cremasteric, from the deep epigastric.

The *veins* from the testis—*spermatic veins*—unite with branches from the epididymis to form the *pampiniform plexus,* which terminates on the left side, passing beneath the sigmoid flexure in the left renal vein, on the right side in the inferior vena cava.

The *lymphatics* are numerous, and terminate in the lumbar glands.

The *nerves* are from the sympathetic system, and form the spermatic plexus.

The *arteries* of the scrotum are derived from the

Cremasteric branch of epigastric;
Superficial external pudic, from the femoral;
Deep external pudic, from the femoral;
Superficial perineal, branch of internal pudic, from internal iliac.

The *seminal vesicles* are two membranous pouches, closely adhering to the under surface of the bladder.

Their size varies, but they usually measure two and one-half inches in length, one-half inch in breadth, and two to three lines in thickness.

Each consists of a tube closed at one end, about four to six inches long, the diameter of a quill, convoluted into a mass. Its structure is analogous to that of the ducts, but thinner.

The *ejaculatory ducts,* two in number, are formed by the union of the vasa deferentia with the duct of the vesiculæ seminales. Each duct is three-fourths to one inch in length, and passes through the prostate gland to terminate at the margin of the sinus pocularis by a slit-like orifice.

The *arteries* are derived from the inferior vesical and middle hæmorrhoidal. The *veins* and *lymphatics* correspond, and the nerves are from the hypogastric plexus of the sympathetic.

The seminal vesicles are not only reservoirs, but secrete a fluid to dilute the spermatic liquid.

The *semen* is a viscid, whitish liquid, composed of a colorless liquid, the *liquor seminis,* and the *spermatozoa* and *seminal granules.*

The *seminal granules* are about one four-thousandth of an inch in diameter.

The *spermatozoa* are the essential elements, and consist of an oval head, a body or middle piece, and a tail.

THE PENIS is composed of three columnar bodies, two corpora cavernosa and one corpus spongiosum, invested with skin, and filled with a peculiar, vascular, sponge-like structure.

It is attached to the pubic arch and symphysis by its root, has a free expanded extremity, the glans penis, or head, and an intermediary portion, the body.

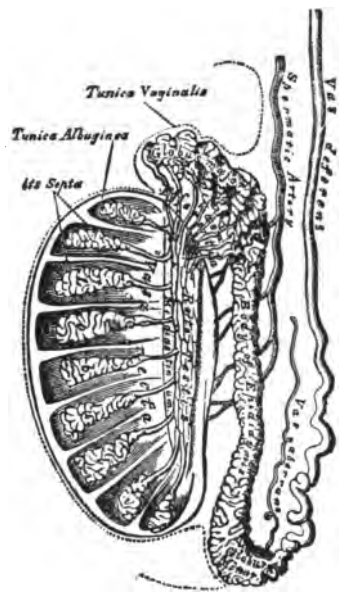


FIG. 127.

Vertical section of testicle. (*After Gray.*)

The upper surface is the dorsum, or back. The *glans* is a blunt, cone-like body, expanded at its base, the corona, and attached by its cervix, or neck.

The summit has a slit-like aperture, the *meatus,* or orifice of the urethra.

The skin adheres loosely to the organ, and has a loose, cup-like fold over the glans, called the *prepuce,* after which it is reflected into the cervix and glans, becoming continuous with

the mucous membrane of the urethra at the meatus, to which it is attached below by a band or bridle—*frænum preputii.*

The skin covering the glans resembles mucous membrane, is very vascular and sensitive, but about the cervix and corona has numerous preputial glands—*glandulæ Tysoni odoriferi,* which secrete the *smegma.*

The superficial fascia is thin, free from adipose tissue, and continuous with that of the abdomen and scrotum.

From the front of the pubis a fibro-elastic fasciculus descends to the root of the penis, called the *suspensory* ligament.

The *corpora cavernosa,* or cavernous bodies, constitute more than two-thirds of the bulk of the organ. They spring as crura from the rami of the ischium and pubis, swell out into the *bulb* of the *cavernous body,* or corpus cavernosum, join each other in the median line, to terminate in a conical extremity, which receives the glans.

They are grooved above for the dorsal vein, and below for the corpus spongiosum.

They each have a strong outer fibrous membrane, which, on uniting, forms a thick partition, complete behind, but incomplete and comb-like in front—*septum pectiniforme.*

From this septum fibro-elastic bands diverge in all directions and form *trabeculæ,* which with the blood-vessels occupying their intervals, form the erectile tissue of the corpora cavernosa.

The *corpus spongiosum* commences as a bulb below the crura and in front of the triangular ligament. It expands anteriorly into the *glans penis,* which fits upon the conical termination of the corpora cavernosa.

The urethra enters above and anteriorly to the bulb, and traverses its entire length to the summit of the glans, opening at the meatus.

The corpus spongiosum consists of an external fibrous coat, thinner and more elastic than that of the corpora cavernosa, and an interior erectile tissue. A thin, muscular layer lines the external fibrous coat, and another is found beneath the mucous membrane of the urethra.

The corpora cavernosa get their blood from the arteries of the corpora cavernosa, and branches from the dorsal artery of the penis, from the internal pudic.

The corpus spongiosum is supplied by the artery of the bulb.

The *arteries* of all three bodies terminate finally in the erectile tissue. Many arterial branches, especially at the root of the penis, form short convolutions—the *helecine arteries,* which terminate in finer vessels, and subsequently open into the spaces of the erectile tissue. Others open directly.

From these spaces the *veins* begin; some wind around the side of the organ to the dorsal vein, while others pass under the pubis to join the prostatic plexus.

The *lymphatics* are numerous; the superficial join the inguinal glands, the deep join the lymphatic plexus about the prostate and other deep lymphatics of the pelvis.

THE MALE URETHRA is the common canal for the emission of semen and urine, extending from the neck of the bladder to the meatus urinarius. It is from eight to nine inches in length, and consists of three portions—the prostatic, membranous, and spongy.

The *prostatic portion* extends from the neck of the bladder to the anterior border (apex) of the prostate gland. It is one and one-quarter inches in length, and is the widest and most dilatable part.

Its floor is raised, and presents:—

Veru montanum, or caput gallinaginis, an elevated ridge;

Prostatic sinus, on each side of the veru montanum;

Orifices of the *prostatic ducts,* in the floor of the prostatic sinuses;

Sinus pocularis, a depression in the median line in front of the veru montanum, presenting the slit-like openings of the ejaculatory ducts. This *cul-de-sac* is one-quarter of an inch in length. It is homologous with the uterus, and has received the name of *utricle,* or *uterus masculinus.*

The *membranous portion* is about three-quarters of an inch in length, extending from the apex of the prostate gland to the corpus spongiosum above and in advance of the bulb. It passes out of the pelvis beneath the symphysis pubis, traversing the triangular ligament. It is the least dilatable portion and has four coats:—

Fibrous, continuous with both layers of the triangular ligament; erectile, continuous with that of the spongy body; an unstriated muscular layer, and a mucous coat.

The *spongy portion* extends from the membranous portion through the corpus spongiosum to the meatus urinarius on the summit of the glans.

The portion within the bulb has received the name of *bulbous portion* of the *urethra.* The spongy portion diminishes gradually in size to near the orifice, where it suddenly dilates into the *fossa navicularis,* contracting again at the meatus, the narrowest part of the urethra.

The mucous membrane is provided with columnar epithelium, except near the meatus, where it is tessellated, a fibro-elastic submucous layer with unstriated muscular fibres, and numerous

minute racemose glands, the *glands* of *Littré*. These latter open forward into the urethra by good-sized orifices, especially one in the upper part of the fossa navicularis, called the *lacuna magna*. Into the bulbous portion of the urethra the ducts of Cowper's glands open.

THE PROSTATE GLAND is a glandular body which resembles in size and form a chestnut, and surrounds the first portion of the urethra between the neck of the bladder and the triangular ligament. It measures one and one-half inches in length and breadth and three-quarters in depth. Its weight, about six drachms. Its flat, under surface rests on the rectum.

It has two lateral lobes, and one middle lobe which corresponds in position to the *vesicle uvula*, and is held in position by the anterior ligaments of the bladder, by a portion of the deep perineal fascia, and of the levator ani muscle.

It is perforated by the urethra and the common seminal ducts.

Its *structure* consists of a mass of fibro-muscular (unstriated) tissue with imbedded follicular pouches, the whole inclosed in a firm fibrous capsule, continuous in front with the triangular ligament, behind with the posterior layer of the deep perineal fascia.

The muscular fibres are longitudinal and circular, the latter surrounding the urethra, continuous behind with the bladder, in front with the fibres about the membranous portion.

The glands open into the floor of the prostatic sinuses by twelve to twenty ducts.

The *arteries* are from the vesical, hæmorrhoidal, and internal pudic.

The *veins* enter into the formation of the prostatic plexus, receive the dorsal vein of the penis, and empty into the internal iliac vein.

The *nerves* are from the hypogastric plexus.

COWPER'S GLANDS, or suburethral glands, are two small lobular bodies, about one-quarter of an inch in diameter, inclosed between the two layers of the deep fascia, situated behind the bulb of the corpus spongiosum, below the membranous portion of the urethra. They are racemose glands and empty their secretion by a long duct into the bulbous portion of the urethra.

Female Organs.

The female organs of generation are divided into the *external*, termed the vulva, or pudendum, consisting of the mons veneris, labia majora and minora, clitoris, meatus urinarius, and

orifice of the vagina; and the *internal,* consisting of the uterus, ovaries, Fallopian tubes, and vagina, with certain accessories.

THE UTERUS is a hollow, muscular organ for the reception of the fecundated ovum and the development and expulsion of the fœtus.

The virgin uterus holds an oblique anterior position in the pelvis, being supported by attachments to the vagina, rectum, bladder, and sides of the pelvis.

It is in contact with the bladder in front, the rectum behind, and above the small intestine.

Its shape is pyriform, compressed from before backward, and measures three inches in length, two in breadth, one in thickness, and weighs from one to one and a half ounces.

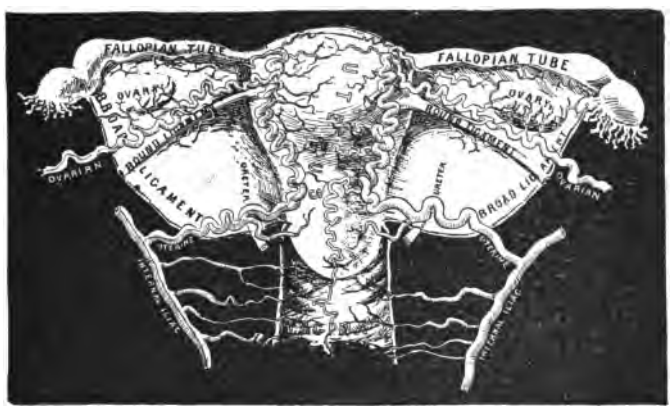


FIG. 128.

Internal female genitals.

It consists of a neck, fundus, and body.

The mouth, *os uteri,* or *os tincæ,* opens into the vagina, being protected by two lips, an anterior thick lip, and a posterior, long and narrow.

The *cavity* of the uterus is triangular △ from side to side, but a mere slit from before backward, and measures two and one-half inches in its longitudinal diameter.

The two upper angles are prolonged to communicate with the Fallopian tubes; the lower angle forms the *ostium internum uteri,* communicating with the cavity of the cervix.

Its *structure* consists of three coats:—

Serous coat, derived from the peritoneum and investing all but the lower anterior quarter;

Muscular coat, about one-half inch thick, composed of unstriped muscular fibres arranged into three layers;

Mucous coat, has numerous tubular follicles, is lined with ciliated columnar epithelium, and has no submucous coat to connect it with the muscular coat.

The mucous membrane of the cervix is thrown into folds, or *rugæ,* which assume on the anterior and posterior walls a branched arrangement, or *arbor vitæ uterina.* It is lined by squamous epithelium, and presents numerous follicular glands—the *ovula of Naboth,* or *glandulæ Nabothi.*

The *arteries* are branches of the ovarian from the aorta, and the uterine from the internal iliac, remarkable for their tortuosity and anastomoses.

The *veins* form plexuses or *uterine sinuses,* the branches of which correspond to the uterine arteries and terminate in the uterine plexuses.

The *lymphatics* are very numerous and terminate in the lumbar and pelvic glands.

The *nerves* are from the ovarian and hypogastric plexuses of the sympathetic.

The *ligaments* of the uterus are folds of peritoneum arranged into four pairs:—

Two anterior, or *vesico-uterine,* passing one on either side from the posterior surface to the cervix uteri;

Two *posterior* or *recto-uterine,* passing between the sides of the rectum and uterus, and inclosing a *cul-de-sac,* the *recto-vaginal pouch,* or *Douglas' pouch;*

A prolongation of this ligament upward to the second sacral vertebra, with some unstriated muscular fibres derived from the uterus and vagina, forms the so-called *utero-sacral ligaments;*

Two *lateral,* or *broad,* extending from the uterus to the sides of the pelvis, dividing it into two portions, and inclosing the Fallopian tubes, ovary, ovarian ligament, uterine blood-vessels, lymphatics, and nerves, and some unstriated muscular fibres;

Two *round ligaments,* are cords of unstriated muscular and fibrous tissue, extending from the side of the fundus uteri to the inguinal canal, where it is lost in the subcutaneous tissue of the pubes.

The canal of Nuck, a pouch of peritoneum, incloses the ligament in the young subject, but is usually obliterated later.

THE OVARIES correspond to the male testicles, and are suspended behind the broad ligament inclosed in its posterior layer.

They are largest from puberty to adult age, and measure one and one-half inches in length, three-quarters of an inch in width, and one-third of an inch in thickness, and weigh from one to two drachms. The inner border is attached to the fundus uteri by the *ovarian* ligament, and its outer border to the fim-

briated extremity of the Fallopian tube by a cord (tubo-ovarian ligament).

The *structure* of the ovary is made up of a reddish, spongy *stroma,* well supplied with blood-vessels, containing numerous *ovisacs,* or *Graaffian vesicles* inclosed in a serous covering derived from the peritoneum.

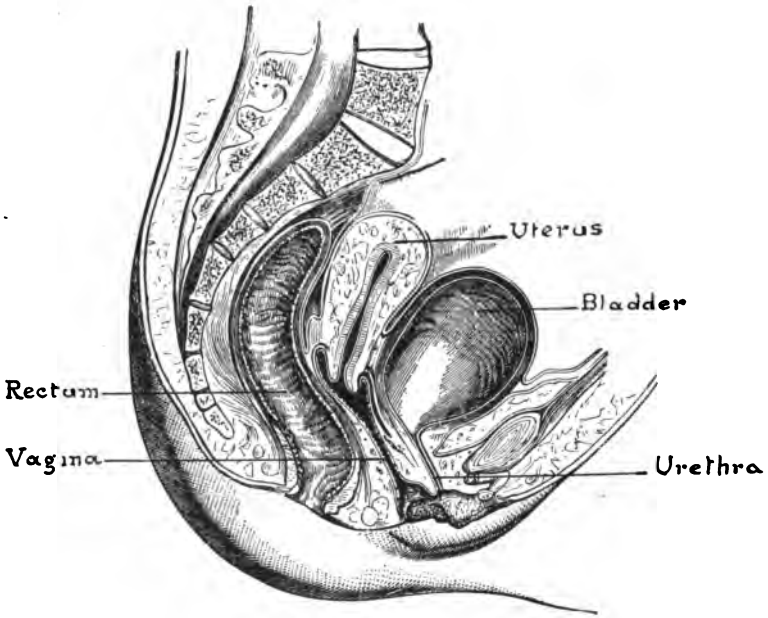


FIG. 129.

Female organs of generation.

The *serous coat* differs from the peritoneum in having a single layer of columnar cells, the *germinal epithelium* of *Waldeyer.*

The *tunica albuginea* is a dense, white, fibrous layer inclosing the ovary, and consisting of a condensation of the stroma. It is perforated at its upper border, *hilus ovarii,* to admit the passage of blood-vessels.

The *Graaffian vesicles,* or ovisacs, containing the human ova, vary in size from microscopic bodies to one-quarter of an inch in diameter, and are most abundant in the periphery.

In *structure* they consist of a fibrous coat—the *ovicapsule*—lined by a basement membrane—*membrana propria*—and a layer of cells, the *membrana granulosa*. The interior is filled with a transparent albuminous fluid, *liquor folliculi*.

The epithelial lining nearest the ovary presents an accumulation of cells—the *germinal eminence*, or discus proligerus, within which is the *ovum* or *egg*.

Discharge.—The Graaffian vesicles approach the surface of the ovary and burst, their contents passing into the opened aperture of the tube, the fimbriated extremity apparently applying it to the region of the bursting ovisac.*

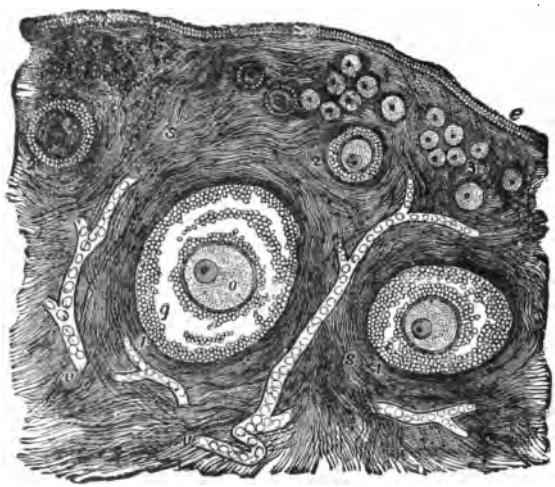


FIG. 130.

Section of an ovary: e, germ epithelium; 1, large-sized follicles; 2, 2, smaller-sized follicles; o, ovum within a Graafian follicle; v, v, blood-vessels of the stroma; g, cells of the membrana granulosa.

The rupture occurs periodically and corresponds to the menstrual flow.

The ovum is surrounded by the tunica vasculosa and some additional epithelial structures (retinacula). It is one-tenth line in diameter, and represents all the elements of an organized cell, being composed of a

* The fimbriated extremity contains no erectile tissue, and the ovum probably falls into the peritoneal cavity and is swept into the tube by the action of the cilia. *(Spigelberg.)*

Cell-wall, or *vitelline membrane,* or *zona pellucida;*
Cell-contents, or *vitellus;*
Nucleus, or *germinal vesicle;*
Nucleolus, or *germinal spot.*

At the seat of the rupture the walls collapse, and the vesicle immediately becomes filled with a blood-tinged fluid, which, together with the hypertrophy of the walls, forms the *false corpus luteum,* which remains and develops for two to three months and gradually disappears.

Under the influence of pregnancy it enlarges for some time, forms the *true corpus luteum* of *pregnancy,* and disappears two to three months after parturition.

The *arteries* are the ovarian from the aorta.

The *veins* form an intricate plexus from which emerge vessels corresponding to the arteries; they form a plexus near the ovary—the pampiniform plexus—which communicates with the uterine and terminates as in the male.

The *lymphatics* are numerous and of large size in the impregnated uterus, and terminate in the lumbar and pelvic glands.

The *nerves* are from the ovarian and hypogastric plexuses of the sympathetic.

The *Parovarium* consists of a series of tortuous tubes extending from the ovary to a main transverse trunk (the epoöphoron), near the Fallopian tubes. It is also called the *organ* of *Rosenmüller,* and is the remains of the Wolffian body of embryo life, and corresponds to the origin of the epididymis in the male.

The *Fallopian tubes,* or oviducts, are the passageways for the ovum from the ovaries to the uterus. They are trumpet-shaped tubes about four inches long, with the largest extremity outward.

Its ovarian extremity is fimbriated; hence its name, *fimbriated extremity.* It is also called *morsus diaboli,* from its supposed erectile action.

One of these fimbriæ extends along the border of the broad ligament to the outer extremity of the ovary, forming the *tubo-ovarian* ligament.

The ovarian orifice—*ostium abdominale,* or *pavillion*—is much larger than the uterine, or *ostium internum.*

The tube has three coats:—

Serous, derived from the peritoneum;

Fibro-muscular, from the uterine walls;

Mucous coat, with ciliated columnar epithelium, continuous with the uterine.

The remains of the duct of Müller form the *hydatid* of *Morgagni,* a small vesicle, attached by a long pedicle near the fimbriated extremity.

The *arteries* are from the ovarian, the *veins* follow the same course, and the *lymphatics* and nerves are the same as the ovarian and uterine.

THE VAGINA is a cylindrical membranous canal extending from the vulva to the uterus. It is formed by the coalescence of two symmetrical tubes in fœtal life.

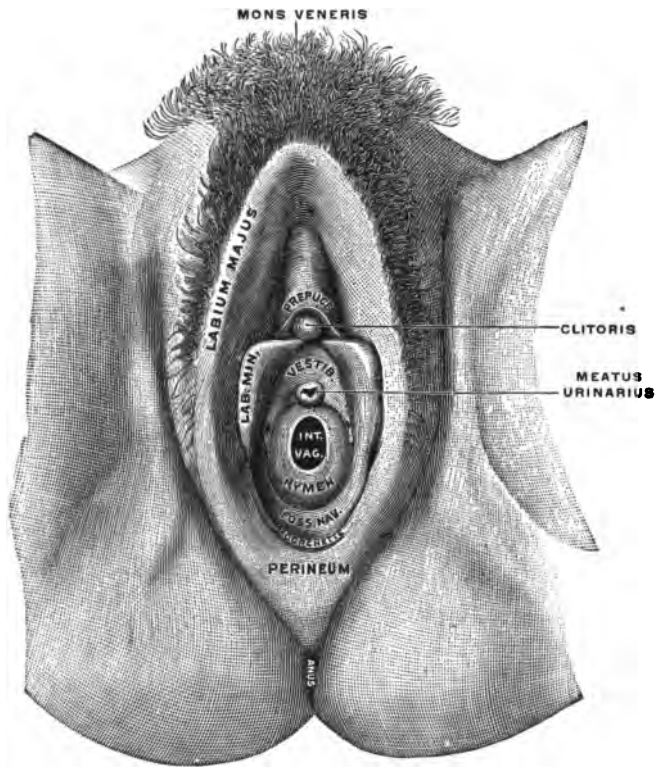


FIG. 131.

External female genitals. (*Eckley.*)

Relations.—It is in relation in *front* with the base of the bladder and urethra, behind its upper fourth with Douglas' pouch, its lower three-fourths connected loosely with the rectum, and *laterally* with the broad ligaments, pelvic fascia, and levator ani muscles.

On the posterior wall just below the cervix uteri the ureters approach each other, leaving a space of only three-quarters of an inch between them,—important in lithotomy.

In the virgin adult it measures about four inches in length, one inch in width, somewhat larger in its middle. Its anterior and posterior walls are in contact.

Its lower orifice or *entrance,* is constricted by a crescentic or circular fold of mucous membrane, the *hymen.*

The upper extremity, or fundus, receives the cervix uteri, extending higher up posteriorly (five to six inches), making the anterior lip apparently the longest.

The mucous membrane has numerous transverse folds, or *rugæ,* passing to either side of a median ridge, both anterior and posterior, the *columnæ vaginæ,* formed by the coalescence of the two tubes in fœtal life. Some of these rugæ present wart-like eminences, most numerous about the entrance of the vagina, where they form the *carunculæ myrtiformes,* the remains of the hymen after intercouse (or after parturition—Budin).

The walls of the vagina are about one line thick and consist of three coats:—

Fibro-elastic coat;

Muscular coat, of unstriated fibres, elastic tissue and blood-vessels, consisting of two layers, external longitudinal and internal circular, and about the entrance the internal circular fibres form the *sphincter vaginæ* (*vide* Perineum);

Mucous or *internal coat,* containing numerous conical papillæ, and covered by squamous epithelium.

The *arteries* are from the vaginal, uterine, vesical, and internal pudic.

The *veins* form an intricate plexus on each side with the returning vessels, corresponding to the prostatic plexus, and join the internal iliac veins.

The *nerves* are from the hypogastric plexus of the sympathetic, also the fourth and fifth sacral and internal pudic nerves.

The *vulva,* or *pudendum,* consists of the mons veneris, labia majora and minora, clitoris, and meatus urinarius.

The *mons veneris* is the prominence of skin over the symphysis pubis, supported upon a mass of adipose tissue, and covered with hair.

The *labia majora* are two folds of skin bounding the vertical fissure of the labia, the junctions of which in front and behind form the anterior and posterior commissures. The labia correspond to the scrotum in the male.

Within the posterior commissure is a depression, *fossa navicularis,* which separates it from a fold of mucous membrane—the *fourchette.*

The triangular space between the anus and the posterior commissure is termed the *perineum.*

The *clitoris* corresponds to the penis in the male, resembling it also in form, structure, and connections.

It is about one and one-half to two inches in length, and consists of a pair of corpora cavernosa, and a double, spongy body, surmounted by a *glans clitoridis.*

The corpora cavernosa arise by two crura attached to the rami of the pubes and ischium like the penis, and united in front by the septum pectiniforme. They curve abruptly down, being attached to the pubic symphysis by a suspensory ligament. The body and crura represent a tripod.

The glans corresponds to that of the male penis, but is not perforated by the urethra. It is covered by the *præputium clitoridis,* a hood-like fold of skin continuous with the nymphæ.

The corpus spongiosum consists of an intermediate portion and semibulbs. The former consist of a plexus of veins, inclosed in a fibrous membrane.

The semibulbs, or *bulbi vestibuli,* are about the size of large almonds, and are situated beneath the vestibule, embracing the orifices of the urethra and vagina. In front of the bulbs, between them and the clitoris, is a smaller plexus called the *pars intermedia.*

The *arteries, nerves,* and *veins* are the same as those of the penis.

The *nymphæ,* or *labia minora,* are two folds of mucous membrane diverging from the præputium clitoridis to the labia, where they are lost. At their superior extremity they divide into two folds, the upper forming the *præputium clitoridis,* the lower one the *frænum.*

These diverging labia inclose a triangular space, the *vestibule,* at the middle of the base of which is situated the orifice of the urethra, or *meatus urinarius.*

The *bladder* in the female is larger and broader than in the male. It is situated behind the pubes, in front of the uterus, from which it is separated by the small intestine, and rests upon the anterior wall of the vagina and cervix uteri.

The *urethra* is a short but capacious canal, one and one-half inches in length, one-quarter inch in diameter, extending beneath the pubic symphysis from the neck of the bladder to the meatus. It lies in the anterior wall of the vagina, and perforates the triangular ligament precisely as does the male urethra (*vide* Urethra).

Below the vestibule is the *entrance* or *orifice* of the *vagina.* The mucous membrane of the labia is reflected continuously to the clitoris, nymphæ, prepuce, and vestibule, and becomes continuous with the vagina and urethra.

Its epithelium is squamous, and its glands racemose, mucous, and sebaceous glands or *glandulæ odoriferi Tysoni.*

The *Bartholine* or *suburethral* glands are two racemose glands about one-third inch in diameter, situated just behind the semibulbs of the spongy body. The ducts, about three-fourths inch long, open between the nymphæ and the vaginal orifice, or the hymen, if present. They secrete mucous.

The *blood-vessels* and *nerves* of the vulva correspond to those of the penis and scrotum (*vide* Internal Pudic Artery).

MAMMARY GLAND.

The mammæ, or breasts, are the milk-secreting organs of the female (being rudimentary in the male). They consist of two large, hemispherical bodies, in the antero-lateral region of the thorax, resting upon the pectoralis major muscle, between the third and seventh ribs, inclosed between the two layers of the superficial fascia.

The nipple (mammilla) is roseate or brownish, and surrounded by an areola of the same color, the skin of which contains numerous sebaceous glands, the *tubercles* of the *areola,* or the *glands of Montgomery.* The skin of the nipple is thin, vascular, and erectile. On its summit are the orifices of the fifteen to twenty milk-ducts, or lactiferous ducts.

Its structure is firm and pinkish-white, consisting of fifteen or twenty lobes forming a racemose gland, held together and invested with fibrous tissue.

Each lobe ends in one of the *tubuli lactiferi,* or *galactophori,* which beneath the areola dilates into a lactiferous sinus, or *galactophorous* sinus, or *ampulla,* and terminates on the summit of nipple in an orifice.

The *arteries* are, the long thoracic, with other branches of the axillary, the internal mammary, and intercostals.

The *veins* follow the corresponding arteries to end in the internal mammary and axillary veins. They form about the base of the nipple a venous circular anastomosis, the *circulus venosus.*

The *lymphatics* terminate in the axillary glands, a few also entering the anterior mediastinal glands.

The *nerves* are from the anterior and lateral cutaneous branches of the intercostals.

Milk, the secretion of the mammary gland, is an emulsion, consisting of a colorless fluid, the *milk-plasma,* holding in suspension the *milk-globules.* It has a specific gravity of 1.028 to 1.034, and slightly alkaline reaction.

The milk is secreted by the swelling and bursting of the cells in the vesicles.

The first secretion at the commencement of lactation is a thin, yellowish fluid, the *colostrum,* the peculiarity consisting in the large, granular colostrum-corpuscles, or corpuscles of Glugé, the entire, unruptured, secreting cells.

THE NERVOUS SYSTEM.

THE nervous system, for description, is divided into two parts: *central* and *peripheral.*

The *central nervous system,* or cerebro-spinal axis, consists of the brain and spinal cord.

The *peripheral nervous system* consists of the cranial and spinal nerves and ganglia, and the sympathetic nerves and ganglia.

The nervous system may also be divided into the *cerebro-spinal system,* that supplying muscles, skin, and mucous membranes; and the *sympathetic system,* presiding over organs and blood-vessels.

Structure.—Nervous tissue consists of three distinct substances, combined in variable proportions in the different parts of the nervous system (white, or fibrous substance; gray, or vesicular substance, and neuroglia).

(a) White substance is found in the cortex of the cord, the interior of cerebrum, in nerves, etc., and is made up of medullated nerve-fibres. These are smooth, round fibres, measuring one two-thousandth to one twelve-thousandth of an inch in diameter, and have each three parts:—

1. *Axis cylinder* is a round or band-like striated structure consisting of fibrillæ;

2. The *medullary sheath,* or white substance of Schwann, which is made up of fatty substance and probably insulates the axis cylinder; and

3. The *neurilemma,* or sheath of Schwann, a delicate, structureless membrane, closely surrounding the medullary sheath, and forming the surface of the nerve-fibres.

Near their termination the nerve-fibres lose their medullary sheath and become non-medullated (Remak's) fibres. Such are the olfactory and most of the sympathetic nerves.

(b) Gray substance, found in the middle of the spinal cord, in the cortex of the brain, in ganglia, etc., consists of three elements: (1) nerve-fibres; (2) nerve-cells; and (3) blood-vessels and connective tissue.

Nerve-fibres.—These are medullated and non-medullated nerve-fibres, axis-cylinder processes, and dendritic processes of nerve-cells.

Nerve-cells are of two kinds—large branched cells, bipolar and multipolar, etc., and small round cells resembling free nuclei.

A *neuron* is the term given to a nerve-cell with its axon, or axis-cylinder process, and its dendritic processes. Each neuron is a distinct and separate unit.

(c) Neuroglia, the supporting framework of nerve-tissue, is made up of a matrix of delicate, fibrillar net-work and small neuroglia cells, and forms an imbedding substance for the other elements.

Nerves are round, white, shining cords, belonging either to the cerebro-spinal or the sympathetic systems. They are made up of bundles of nerve-fibres held together by fibro-connective tissue, the *epineurium.* The individual fibres are held together within the bundles by connective tissue, the *endoneurium.*

The nerve-fibres have a twofold function—sensory and motor.

Sensory, or afferent, transmit impressions from the periphery to the centres.

Motor, or efferent, transmit impressions from the centres to the periphery.

Ganglia form independent nerve-centres, similar to but less complex than the brain. They are connected with some of the cranial nerves, all of the spinal nerves, and form an important part of the sympathetic system.

Terminations.—The motor nerves end in the voluntary and involuntary muscles, the former having special endings called the *motorial end plates.*

The sensory nerves terminate in the peripheral organs, to which they are distributed by first becoming non-medullated, and then dividing and joining one another to form a minute plexus or by means of one of the three special endings, called *"peripheral end organs":* (1) tactile corpuscles of Wagner; (2) end bulbs of Krause; or (3) the Pacinian corpuscles.

CEREBRO-SPINAL AXIS.

The cerebro-spinal axis is divided into two grand divisions:—

The encephalon, or brain, and spinal cord.

Membranes of the Brain.—The membranes of the brain are three—dura mater, arachnoid, and pia mater.

Dura mater is a dense, white, fibrous membrane lining the interior of the skull, and forming its internal periosteum, to which it is adherent at the sutures.

It contains the sinuses or venous channels (already described), and forms three partitions for the support of the brain—the falx cerebri, falx cerebelli, and tentorium.

Falx cerebri is an arched or sickle-shaped process received into the longitudinal fissure. It contains in its upper and lower margins the superior and inferior longitudinal sinuses.

Tentorium cerebelli is a lamina, arched across, between the superior borders of the petrous portion of temporal on either side, the anterior and posterior clinoid processes in front, and the transverse ridge of the occipital behind, for the support of the posterior lobes of the cerebrum. It incloses the superior petrosal and lateral sinuses.

Falx cerebelli is a small median partition descending from the tentorium to the foramen magnum, and separating the lateral lobes of the cerebellum.

The *arachnoid* is a thin, transparent, delicate membrane consisting of fibrous and elastic tissue, and situated between the dura and pia mater. From the former it is separated by the *subdural space;* from the latter, by the *subarachnoid space.*

Unlike the pia mater, it does not dip into the sulci on the brain surface, except the sylvian and great longitudinal fissures.

The *subarachnoid space* contains cerebro-spinal fluid, and communicates through certain foramina with the cavities of the brain. The space is much broken up by loose connective tissue, which connects it to the pia mater.

The three expanded portions of the subarachnoid space are the cisterna magna, cisterna pontis, and cisterna basalis.

The *cisterna magna* is placed over the roof of the lower portion of the fourth ventricle, and communicates with the fourth ventricle by the foramen of Majendie and two smaller foramina: those of Keyes and Retzius.

The *cisterna pontis* is placed in front of the pons Varolii.

The *cisterna basalis* incloses the circle of Willis.

The *Pacchionian bodies* are projections of the arachnoid into, but not through, the dura mater, and are most numerous along the great longitudinal sinus. They make impressions on the under surface of the calvarium, from which, however, they are separated by a thin layer of dura mater. Their function is to allow the passing of fluid from the subarachnoid space into the brain-sinuses when the blood-pressure in the sinuses is lower than in the subarachnoid space.

Pia mater, the investing membrane of the brain, is composed of a net-work of blood-vessels derived from the vertebral and internal carotid arteries, held together by delicate connective tissue. It dips into the sulci, and is prolonged into the ventricles, forming the velum interpositum, or tela choroidea superior, and the tela choroidea inferior. The former covers the third ventricle and extends into the lateral ventricles, carrying

in its margins the choroid plexus of the lateral and third ventricles. It is perforated by two slit-like foramina, one communicating with each lateral ventricle.

The tela choroidea inferior forms the roof of the lower part of the fourth ventricle. It contains nerves and lymphatics.

The Encephalon, or The Brain.

The encephalon, or brain, consists of four distinct portions—the cerebrum, cerebellum, pons Varolii, and medulla oblongata. The average weight of the brain in the male adult is forty-nine and a half ounces, in the female forty-four ounces, of which the cerebrum is about seven-eighths. The maximum male brain weighs sixty-five ounces; minimum, thirty-four ounces. The maximum female brain weighs fifty-six ounces; minimum, thirty-one ounces. The brains of idiots seldom weigh more than twenty-three ounces. Excepting the whale and elephant, the human brain is heavier than that of all the lower animals.

The brain is developed from the anterior portion of the primitive neural tube. This expands and later becomes constricted into three primary brain-vesicles, which are called the forebrain (prosencephalon), midbrain (mesencephalon), and hind-brain (rhombencephalon). The forebrain becomes differentiated later into the telencephalon and diencephalon; and the hind-brain likewise is differentiated into two parts: the metencephalon and the myelencephalon.

From these brain-vesicles are developed the following:—

- Encephalon, or Brain,
  - Rhombencephalon, or hind-brain,
    - Myelencephalon,
      - Medulla oblongata,
      - Lower part of fourth ventricle.
    - Metencephalon,
      - Cerebellum,
      - Pons Varolii,
      - Upper part of fourth ventricle.
    - Isthmus rhombencephali (narrow part connecting with mesencephalon),
      - Superior cerebellar peduncles,
      - Valve of Vieussens.
  - Mesencephalon, or midbrain,
    - Mesencephalon, or midbrain,
      - Corpora quadrigemina,
      - Crura cerebri,
      - Aqueduct of Sylvius.

- Encephalon, or Brain (Continued)
  - Prosencephalon, or forebrain,
    - Thalamencephalon, or diencephalon,
      - Optic thalami,
      - Subthalamic regions,
      - Pituitary and pineal bodies,
      - Structures in interpeduncular space,
      - Optic nerve and retina,
      - Hinder part of third ventricle.
    - Telencephalon,
      - Cerebral hemispheres,
      - Olfactory lobes,
      - Lateral ventricles,
      - Foramina of Monro,
      - Anterior portion of third ventricle.

THE MEDULLA OBLONGATA is the upper expanded portion of the spinal cord, extending between the lower border of the pons and the upper border of the atlas. It is divided by two fissures—the anterior and posterior median fissures—into two halves, each one of which is subdivided into four columns, from before backward, the following:—

(a) Anterior pyramids, or corpora pyramidalia, are two pyramidal masses of white nervous matter, placed between the anterior median fissure and the olivary body, and continuous with the anterior columns of the cord below;

(b) Lateral tract and olivary body, are continuous with the lateral columns of the cord below;

(c) Restiform bodies are continuous below with the posterior columns of the cord. They are composed of the fibres of the columns of Goll and Burdach and the direct pyramidal tract. They diverge, the interval between them being the lower portion of the fourth ventricle.

The *structure* of the medulla oblongata consists of both white and gray matter, the former arranged into four columns, the latter contained in the interior.

The gray matter of the medulla is partly arranged into masses and partly continuous with the gray matter of the cord. The posterior horns are called here "the tubercles of Rolando." On the floor of the fourth ventricle the ganglion-cells are arranged into *nuclei,* from which several of the cranial nerves have their origin.

THE PONS VAROLII connects the cerebrum above with the cerebellum behind and the medulla oblongata below. On its under surface it presents a groove for the passage of the basilar artery. The upper surface forms a portion of the floor of the

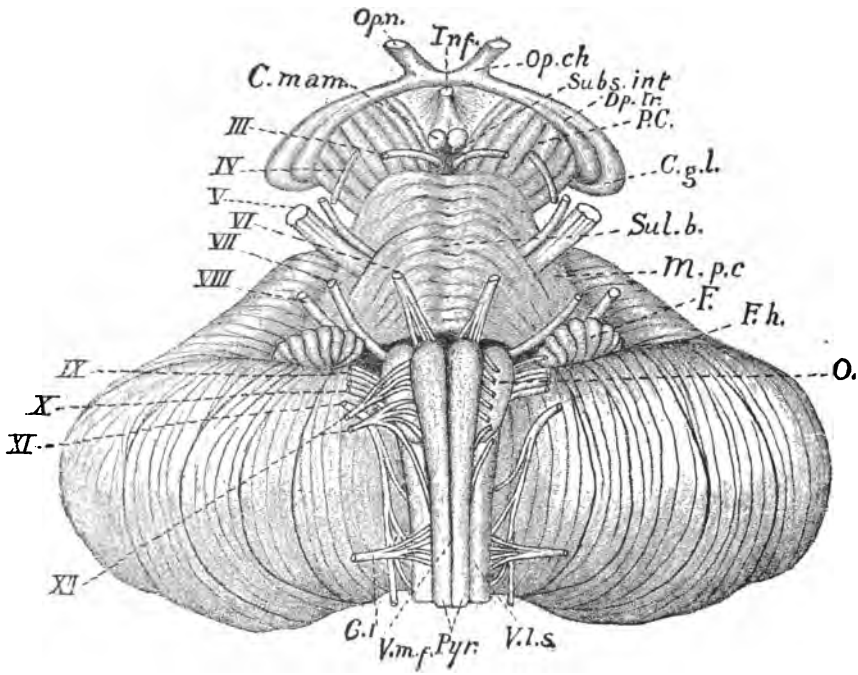


FIG. 132.

Surface anatomy of the myelencephalon. (Roman numerals refer to cranial nerves.) C. 1, first cervical spinal nerve; C. mam., corpus mammillare; Op. n., optic nerve; Inf., infundibulum; Op. ch., optic chiasm; Subs. int., substantia interpeduncu-geniculate body; Sub. b., basilar sulcus; M. p. c., middle peduncle of cerebellum; F., flocculus; F. h., horizontal fissure; O., olive; V. l. s., ventrolateral sulcus; Pyr., pyramid; V. m. f., ventral median fissure. (*After Van Gehuchten.*) (*Whitehead.*)

fourth ventricle, and on either side, under the name of the crus cerebelli, it passes to the cerebellum, forming its middle peduncle.

CEREBELLUM.

The *cerebellum,* or little brain, occupies the inferior occipital fossæ beneath the great cerebral lobes, from which it is separated by the tentorium. Its average weight is a little over five ounces in the male, and is proportioned to the greater brain about one to twenty. It is oblong, flattened from above downward, and

divided into two lateral hemispheres connected by a central portion, the vermiform process.

It is composed of gray and white matter—the former upon the surface. It is not convoluted, like the cerebrum, but consists of a number of thin plates, *folia,* arranged in a series of crecentric curves, with the concavity forward.

The cerebellum consists of a central lobe, or vermis, and two lateral hemispheres. The latter are separated on the inferior surface of the cerebellum by a deep hollow, *the vallecula,* which lodges the medulla oblongata. The floor of the vallecula is formed by the inferior portion of the vermis.

The incisura cerebelli anterior, separates the hemispheres in front, and rests against the corpora quadrigemina;

The incisura cerebelli posterior, separates the hemispheres behind, and receives the upper portion of the falx cerebelli;

The great horizontal fissure separates the cerebellum into a superior and an inferior surface.

The upper surface of the cerebellum shows the superior vermis, with its corresponding lobes in the hemispheres. These latter are separated from each other by fissures. The following table gives the arrangement of the lobules:—

Great horizontal fissure.

	Frenulum.	Lingula.	Frenulum.	
Pre-				central fissure.
	Ala.	Lobus centralis.	Ala.	
Post-				central fissure.
	Anterior crescentic lobule.	Lobus culminis.	Anterior crescentic lobule.	
Pre-				clival fissure.
	Posterior crescentic lobule.	Lobus clivi.	Posterior crescentic lobule.	
Post-				clival fissure.
		Folium cacuminis.	Posterior superior lobule.	
Great				horizontal fissure.

The inferior surface of the cerebellum presents the deep depression, the vallecula, which renders the connection between

the vermis and the hemispheres less intimate. The divisions of the vermis and their corresponding lobules in the hemispheres are as follows:—

Great				horizontal fissure.
	Flocculus.	Tuber valvulæ.	Flocculus.	
Post-				pyramidal fissure.
	Lobulus biventer.	Pyramis.	Lobulus biventer.	
Pre-				pyramidal fissure.
	Amygdala.	Uvula.	Amygdala.	
Post-				nodular fissure.
	Posterior inferior lobule.	Nodule.	Posterior inferior lobule.	
Great				horizontal fissure.

The cerebellum is connected with the encephalon by the *peduncles* of the *cerebellum,* three in number, from above downward, as follows:—

Superior, or processus e cerebello ad testes, pass to the cerebrum;

Middle, or processus ad pontem, the transverse fibres of the pons Varolii, connect the hemispheres;

Inferior, or processus a cerebello ad medullam, the restiform bodies of the medulla oblongata, connect with medulla oblongata.

The internal *structure* of the cerebellum consists of an arbor vitæ arrangement of gray matter, inclosing a white mass. In the centre of the latter is found a grayish, dentated mass, the *corpus dentatum,* an irregular capsule of gray matter opening anteriorly.

THE CEREBRUM

consists of a large, ovoidal mass, divided into two lateral halves, or *hemispheres,* by the great longitudinal fissure, connected by a white, transverse commissure—the corpus callosum. The surface is irregularly marked by convolutions, or gyri, separated from each other by irregular depressions, fissures, or sulci. The outer surface is composed of gray matter, which, from its location, is called the cortical substance. The interior surface, for the most part, is white.

The principal fissures of the brain are five, as follows:—

1. The *great longitudinal fissure*, separating the two hemispheres from one another.
2. The *great transverse fissure of Bichat*, between the cerebellum and the cerebrum, admitting the pia mater to form the velum interpositum.
3. The *fissure of Sylvius*, beginning at the anterior perforated space and ascending obliquely.
4. The *fissure of Rolando*, descends from near the middle of the great longitudinal fissure to join the fissure of Sylvius.

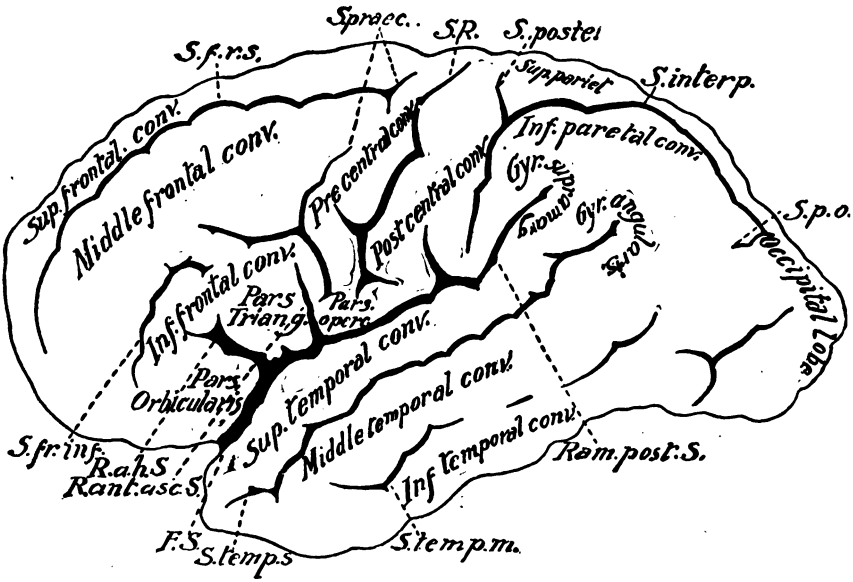


FIG. 133.

Left side of human cerebrum. S. fr. s., superior frontal sulcus; S. præc., precentral sulcus; S. R., central sulcus of Rolando; S. poste., Post-central sulcus; S. interp., interparietal sulcus; S. p. o., parieto-occipital fissure; Ram. post. S., posterior ramus of fissure of Sylvius; S. temp. m., middle temporal sulcus; S. temp. s., superior temporal sulcus; F. S., fissure of Sylvius; R. ant. asc. S., ascending anterior ramus of fissure of Sylvius; R. a. h. S., horizontal anterior ramus of fissure of Sylvius; S. fr. inf., inferior frontal sulcus. (*After Van Gehuchten.*) (*Whitehead.*)

5. The *parieto-occipital fissure*, on the postero-lateral aspect of the cerebrum.
6. The callaso-marginal fissure.
7. The collateral fissure.
8. The limiting sulcus of Reil.

The principal lobes of the brain are six, as follows:—

1. *Frontal lobe,* on the outer surface of the brain; it is bounded below by the fissure of Sylvius, and behind by the fissure of Rolando. On the mesial surface it is bounded by the callaso-marginal fissure, and on the inferior surface it is bounded behind by the stem of the Sylvian fissure.

On the outer surface it is divided into the

(a) Gyrus frontalis ascendens;
(b) Gyrus frontalis superior;
(c) Gyrus frontalis medius;
(d) Gyrus frontalis inferior.

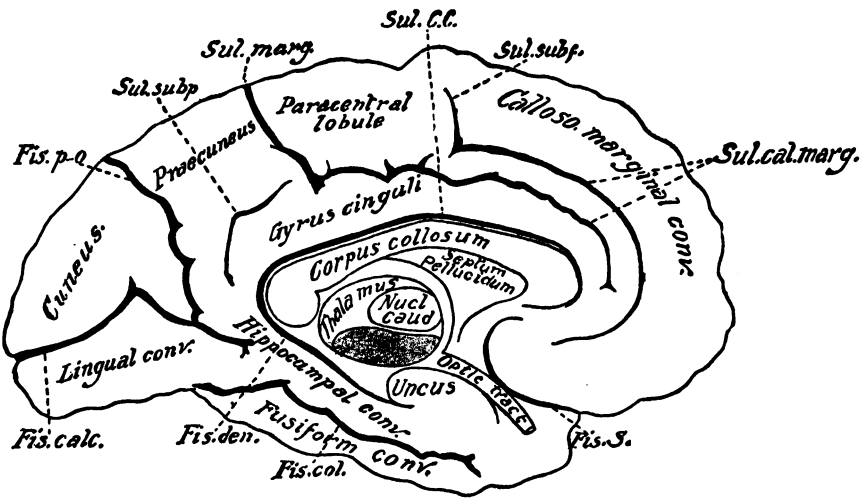


FIG. 134.

Convolutions and fissures of the median and tentorial surfaces of the right cerebral hemisphere. Fis. S., fissure of Sylvius; Sul. cal. marg., calloso-marginal sulcus; Sul. subf., subfrontal sulcus; Sul. C. C., sulcus of corpus callosum; Sul. marg., marginal sulcus; Sul. subp., subparietal sulcus; Fis. p. o., parieto-occipital fissure; Fis. calc., calcarine fissure; Fis. den., dentate fissure; Fis. col., collateral fissure. (*After Van Gehuchten.*) (*Whitehead.*)

On the mesial surface it is divided into

(a) Gyrus marginalis;
(b) Paracentral lobule.

On the orbital surface it is divided into

(a) Gyrus orbitalis internus;
(b) Gyrus orbitalis anterior;
(c) Gyrus orbitalis posterior.

2. *Parietal lobe,* lies between the fissure of Rolando, the parieto-occipital, and the fissure of Sylvius, and consists of five gyri:—

(a) Ascending parietal; } Supramarginal,
(b) Superior parietal; } Angular,
(c) Inferior parietal, } Post parietal;

3. *Occipital lobe,* lies at the posterior aspect of the cerebrum and is divided into first, second, and third occipital convolutions.

4. *Temporo-sphenoidal lobe,* occupies the middle fossa of the skull.

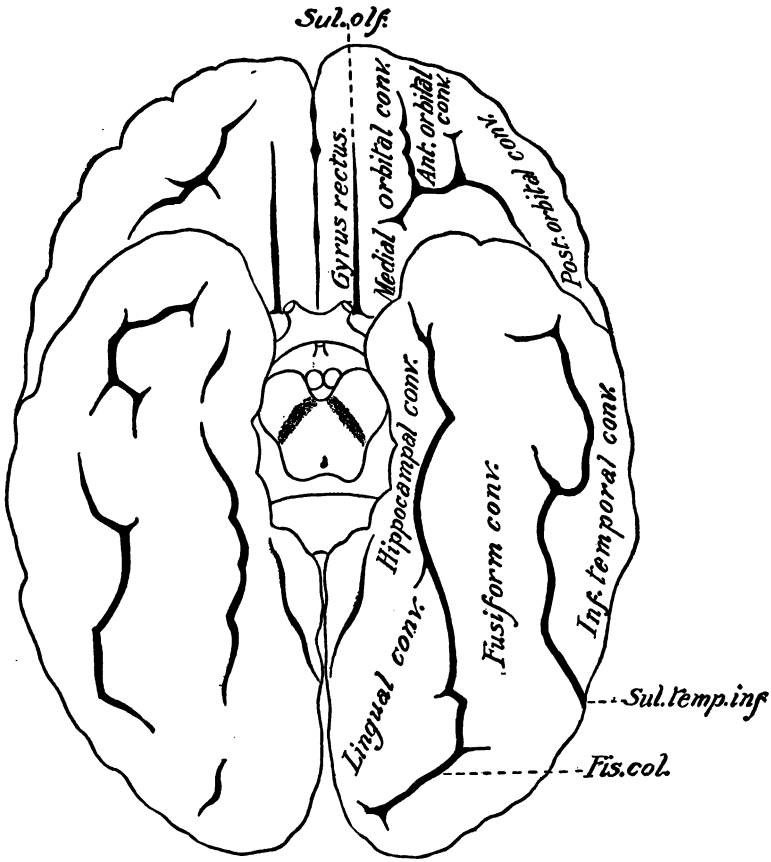


FIG. 135.

Inferior aspect of cerebral hemisphere. Sul. olf., olfactory sulcus; Sul. temp. inf., inferior temporal sulcus; Fis. col., Collateral fissure. (*After Van Gehuchten.*) (*Whitehead.*)

5. *Island of Reil,* or central lobe, lies within the fissure of Sylvius. It consists of six convolutions—the *gyri operti.*

6. The limbic lobe surrounds the corpus callosum. Its extremities are united by the roots of the olfactory tract.

The inner or median surface of the hemispheres presents five fissures, as follows:—

1. Colloso-marginal.
2. Parieto-occipital.
3. Calcarine.
4. Occipito-temporal or collateral.
5. Dentate fissure, or sulcus hippocampi.

The lobes on the internal surface are six in number, as follows:—

1. Gyrus fornicatus, or convolution of the corpus callosum, descends as the gyrus hippocampi and terminates as the uncinate gyrus.
2. Marginal, or first frontal convolutions.
3. Quadrate, or præcuneus.
4. Cuneus, or occipital lobule.
5. Uncinate gyrus.
6. Temporo-sphenoidal lobe.

The *inferior surface* of each hemisphere is divided into three lobes—the anterior, middle, and posterior. The two former occupy the anterior and middle fossa of the skull and the posterior rests upon the cerebellum, separated from it by the tentorium. This surface presents for study from before backward the following points:—

The *longitudinal fissure*, separates the two hemispheres;

Corpus callosum, the great transverse commissure of the cerebrum, extending by means of its *peduncles* to near the Sylvian fissure;

Lamina cinerea, is a thin, gray layer, forming the anterior part of the inferior boundary of the third ventricle;

Olfactory nerve, with its bulb;

Fissure of Sylvius, between the anterior and middle lobes of the cerebrum, and lodges the middle cerebral artery;

Anterior perforated space, transmits vessels to the corpus striatum;

Optic commissure, is formed by the junction of the optic tracts;

Tuber cinereum, is a gray eminence between the corpora albicantia and optic tracts, and forms part of the floor of the third ventricle;

Infundibulum, is a tube of gray matter connecting the pituitary body with the third ventricle;

Pituitary body, is a small, vascular, bilobed body, connected by the infundibulum and occupying the sella Tursica (for histology *vide* "Ductless Glands");

Corpora albicantia, or *mammillaria*, are two white, rounded masses, formed by the folding of the anterior crura of the fornix, and are sometimes called the bulbs of the fornix;

Posterior perforated space, allows the passage of blood-vessels to the optic thalami;

Crura cerebri, or cerebral peduncles, connect the cerebrum with the medulla, cerebellum, and spinal cord; it consists of the anterior portion,

or *crusta*, and the posterior portion, or *tegmentum*, between which is a mass of gray matter—the *locus niger;*

Pons Varolii, covers up the posterior portion of the cerebral lobes.

INTERIOR OF THE CEREBRUM.—The interior of the cerebrum, viewed above the level of the corpus callosum, presents a white surface—the *centrum ovale minus*, the margins of which are convoluted gray matter, and are called *labia cerebri*. It is studded throughout with minute blood-vessels—puncta vasculosa.

The hemispheres, viewed on a level with the corpus callosum, present a large white mass—the *centrum ovale majus*—in the centre of which is the connecting band, the corpus callosum.

Corpus Callosum.—This connecting band forms the roof of the lateral ventricles. It is about four inches in length and varies from an inch and a half to two inches in width, presenting in front a bend, or genu, below which it terminates in the tuber cinereum through the lamina cinerea.

Posteriorly it forms a thick, rounded fold—the *splenium*, or pad—which is continuous with the *fornix*.

The *peduncles* of the *corpus callosum* are two reflected bundles of white matter given off near the anterior termination of the corpus, and each passing backward across the anterior perforated space of its own side to the *fissure of Sylvius*.

The superior surface of the *corpus callosum* shows a depression—the raphé—bounded on each side by elevated bands, the *striæ longitudinales*, or nerves of Lancisi. External to these are the *striæ longitudinales laterales*. On either side of the raphé are many transverse lines—the lineæ transversæ, which indicate the direction of the fibres of the *corpus*.

THE CEREBRAL COMMISSURES are connecting bands of gray and white matter, pursuing either a transverse or antero-posterior course.

Transverse:—

Anterior, middle, and posterior commissures;
Corpus callosum;
Optic chiasm;
Fornix;
Pons Varolii;
Posterior medullary velum.

Antero-posterior:—

Corpus callosum (nerves of Lancisi);
Fornix;
Fasciculus uncinatus;
Tænia semicircularis;
Gyrus fornicatus;

Fasciculus longitudinales inferior;
Olfactory tracts;
Crura cerebri;
Peduncles of pineal gland;
Processus a cerebello ad testes.

VENTRICLES OF THE BRAIN.

The interior of the brain contains five distinct cavities, named the *ventricles* of the *brain,* situated as follows: Two lateral ventricles in the upper part, within the substance of the hemispheres, the third ventricle between the optic thalami at the base of the brain, the fourth ventricle between the medulla oblongata and the cerebellum, and the fifth ventricle within the septum lucidum between the two lateral ventricles.

The ventricles intercommunicate—the two lateral ventricles with the third by means of the foramen of Monro, the third with the fourth ventricle by means of the iter a tertio ad quartum ventriculum, and, in the fœtus, with the fifth, and through the infundibulum with the cavity of the pituitary body.

THE LATERAL VENTRICLES are bounded as follows:—

The *roof,* the corpus callosum; the *floor* is formed by the following parts from before backward: corpus striatum, tænia semicircularis, optic thalamus, choroid plexus, corpus fimbriatum and fornix; *internally,* by the septum lucidum; *externally,* in front and behind by the brain-substance. ***Each lateral ventricle presents three cornua—the anterior cornu, posterior cornu, or digital cavity, and the middle cornu.***

The *anterior cornu* curves outward and forward over the corpus striatum and into the anterior lobe.

The *middle cornu* passes into the middle lobe, ascending to the transverse fissure at the base of the brain. Its course is backward, outward, downward, forward, and inward (B., O., D., F., I.).

The *posterior cornu* runs backward into the posterior lobe, its course being backward, outward, and inward (B., O., I.).

Parts of Lateral Ventricle—Corpus Callosum.—Described above.

Septum Lucidum.—Forms the internal boundary of the lateral ventricle. It consists of two layers of white and gray matter, and is attached above to the under surface of the corpus callosum, below to the fornix, and anteriorly to the prolongation of the corpus callosum.

Between the laminæ forming the septum is a narrow interval —the fifth ventricle.

The Corpus Striatum.—Situated in the lateral ventricle, its broad end directed forward into the fore part of the body and

anterior cornu of the ventricle, its narrow end directed outward and backward, and separated from its fellow by the thalami optici.

The intraventricular portion is called the caudate nucleus, the extraventricular the lenticular nucleus, the two separated by the internal capsule.

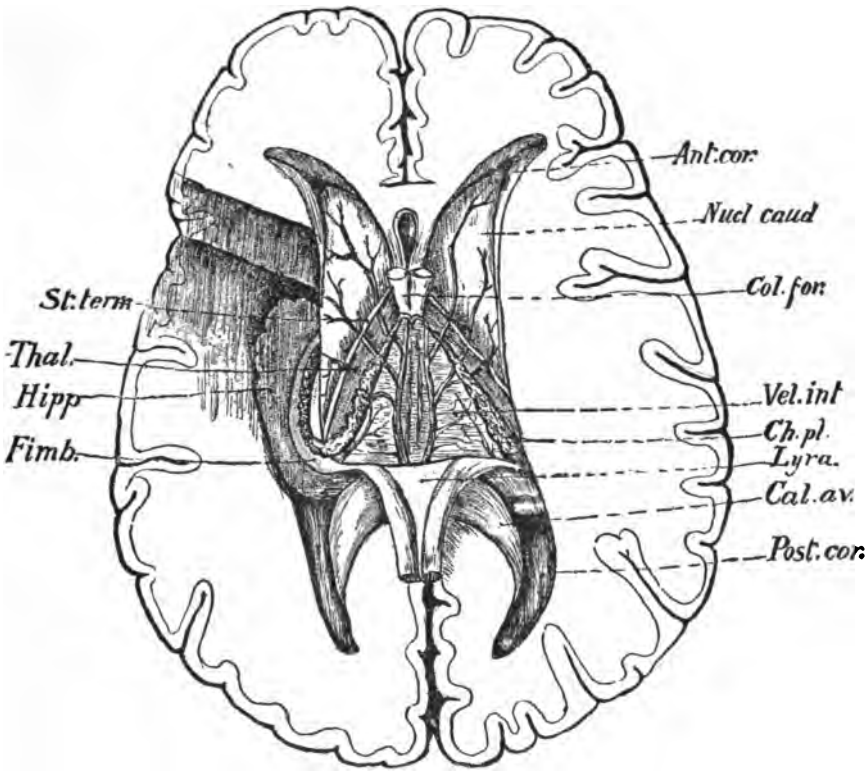


FIG. 136.

The lateral ventricles and choroid plexus. St. term., stria terminalis; Thal., thalamus; Hipp., hippo-campus; Fimb., fimbria; Ant. cor., anterior cornu of lateral ventricle; Nucl. caud., nucleus caudatus; Col. for., columns of the fornix; Vel. int., Velum interpositum; Ch. pl., choroid plexus; Cal. av., calcar avis; Post. cor., posterior cornu of lateral ventricle. (*After Gray.*) (*Whitehead.*)

The *internal capsule* is a large layer of white fibres, derived from the medulla and crura cerebri, separating the lenticular nucleus from the caudate nucleus anteriorly, and the lenticular nucleus from the optic thalamus posteriorly.

The *external capsule* is a small layer of white fibres on the outer surface of the corpus striatum, between the lenticular nucleus and the claustrum.

The *claustrum* is a convoluted layer of gray fibres between the external capsule and the island of Reil.

The Tænia Semicircularis, or Horny Band of Tarinus.—A band of medullary substance in the furrow between the corpus striatum and the optic thalamus. Its anterior portion descends with the anterior pillar of the fornix, its posterior portion passes into the descending horn. Beneath it is the vena corporis striati.

The *choroid plexus,* a vascular membrane, occupying the margin of a fold of pia mater, known as the velum interpositum. It runs across the floor of the lateral ventricle, and communicates with its fellow of the opposite side through the foramen of Monro. Posteriorly it descends into the middle horn of the lateral ventricle.

The *corpus fimbriatum* (tænia hippocampi), a narrow white band behind the choroid plexus. It is the lateral edge of the posterior pillar of the fornix.

The *fornix,* a lamella of white fibrous matter, beneath the corpus callosum, continuous with it posteriorly, but separated from it anteriorly by the septum lucidum. It consists of two symmetrical halves which join to form the *body,* each half having an anterior and posterior *crus* where they do not join.

The *anterior crura* curve down to the base of the brain, where each crus spreads out and curves upon itself to form the corpus albicans of that side. From this point it passes to the corresponding optic thalamus.

The *posterior crura,* at their commencement, are joined to the under surface of the corpus callosum. They pass downward into the descending horns of the lateral ventricles, being continuous with the concave borders of the hippocampi majores.

The lateral edge of the posterior crus is called the corpus fimbriatum.

The lyra is a series of lines, some transverse, others longitudinal and oblique, on the under surface of the fornix, between the diverging posterior crura.

Optic Thalamus.—The thalami optici are two large ganglionic masses, situated between the diverging portions of the corpora striata. Each thalamus rests upon the corresponding crus cerebri.

The thalamus is bounded externally by the corpus striatum and tænia semicircularis, and internally forms the lateral boundary of the third ventricle.

Its upper surface is partly covered by the fornix. Its under surface forms the roof of the descending horn of the lateral ventricle.

Its posterior and inferior part exhibits two rounded eminences, the *external* and *internal geniculate bodies.* Its anterior extremity forms the posterior boundary of the foramen of Monro, which foramen connects the two lateral ventricles with the third.

Velum interpositum, a vascular membrane, reflected from the pia mater into the interior of the brain through the transverse fissure. It passes beneath the posterior border of the corpus callosum and fornix, and above the corpora quadrigemina, the pineal gland, and the optic thalami. It forms the roof of the third ventricle. Its anterior extremity passes on each side into the corresponding lateral ventricle, forming the anterior extremity of the choroid plexus. The vascular fringes of the velum interpositum projecting into the third ventricle are called the choroid plexuses of the third ventricle.

It has two veins, the venæ Galeni, which run along its under surface and are formed by the veins of the choroid plexuses and the venæ corporis striata. The venæ Galeni unite to form a single trunk and empty into the straight sinus.

The *posterior cornu* of the lateral ventricle runs into the *substance* of the posterior lobe. On the floor of this horn is an eminence corresponding to a sulcus between two convolutions, and called the *hippocampus minor.*

Between the posterior and middle horns is another eminence—the *eminentia collateralis,* or *pes accessorius.*

The *hippocampus major,* or *cornu ammonis,* a white eminence running the entire length of the floor of the middle horn. This eminence is the doubled-in surface of the gyrus fornicatus.

The lower extremity of the hippocampus major is called the pes hippocampus.

The *fascia dentata,* the gray and serrated edge of the middle lobe. It is really external to the cavity of the middle cornu.

THE THIRD VENTRICLE is a mere fissure in the median line of the cerebrum, situated between the optic thalami. It communicates with the lateral ventricle by the foramen of Monro and with the fourth ventricle by the iter a tertio ad quartum ventriculum. The cavity is crossed by three commissures—the anterior commissure, a white, rounded cord; the middle or soft commissure, composed of gray matter; and the posterior commissure, a white band connecting the two optic thalami. It is bounded by the following structures:—

The *roof*, by the velum interpositum, suspending the choroid plexuses of the third ventricle, and *laterally* the peduncles of the pineal gland; *floor*, by the parts inclosing the interpeduncular space at the base of the brain, viz.: the lamina, cinerea, tuber cinereum and infundibulum, corpora albicantia and the posterior perforated space; *laterally*, by the optic thalami; *in front*, by the anterior commissure and anterior crura of the fornix; *behind*, the posterior commissure and the iter a tertio ad quartam ventriculum.

THE FOURTH VENTRICLE is a diamond-shaped cavity between the cerebellum behind and the posterior surface of the medulla oblongata and pons in front. It is inclosed behind by the pia mater, which contains an opening for the exit and entrance of

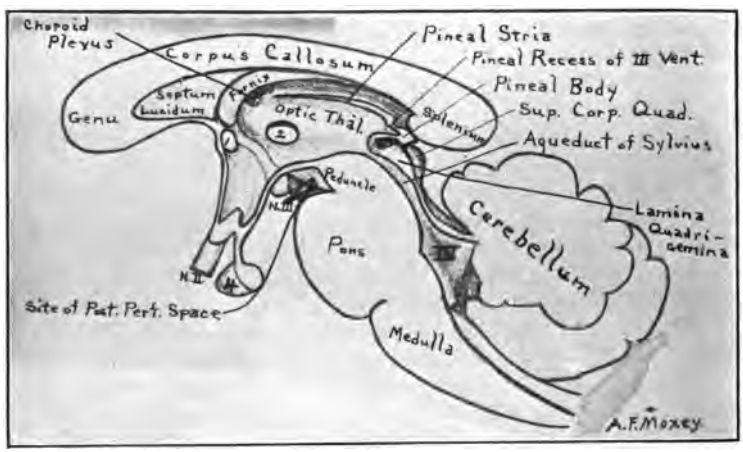


FIG. 137.

Mesial section of brain and brain stem. 1, anterior commissure; 2, middle commissure; 3, posterior commissure; 4, pituitary body; IV, fourth ventricle.

the subarachnoid fluid from the subarachnoidean space of the brain and spinal cord, and a vascular fold of pia mater—the choroid plexus. It communicates in front with the third ventricle by the iter a tertio ad quartam ventriculum. It is bounded as follows:—

The *roof*, valve of Vieussens and the cerebellum, containing in front the foramen of Magendie, by which it communicates with the subarachnoidean space; the *floor*, the posterior median fissure of the medulla and pons, the fovea posterior, the orifice [ventricle of the central canal of the cord] of Aurantius, the locus cæruleus, and the tænia violacea,

the calamus scriptorius and the fasciculi teretes; *anteriorly*, the pons Varolii and medulla oblongata; *posteriorly*, the cerebellum; *laterally*, the processus a cerebello ad testes, the restiform bodies, and posterior pyramids of the medulla.

Its lining membrane is continuous with that of the third ventricle. The gray matter of the floor of the fourth ventricle presents masses for the origin of certain cranial nerves.

THE FIFTH VENTRICLE is a narrow fissure, formed within the two laminæ of the septum lucidum, being originally a part of the great longitudinal fissure. It is bounded:—

Above, by the under surface of the corpus callosum;
Below, by the anterior part of the fornix;
Laterally, by the lateral ventricles, from which it is separated by the septum lucidum.

It is not lined with epithelium.

THE MESENCEPHALON includes those portions of the brain substance which connect the cerebrum, cerebellum, and medulla oblongata together, and comprises the following structures:—

Crura cerebri, before described (*ante*, p. 294).

The *valve of Vieussens*, or *anterior medullary velum*, is a thin layer of white matter stretched between the processes e cerebello ad testes, and forming the roof of the iter a tertio ad quartum ventriculum. It presents an elevated ridge descending on its upper part from the corpora quadrigemina—the *frænulum*.

Corpora or *tubercula quadrigemina*, or optic lobes, are four spherical eminences, placed in pairs above the valve of Vieussens, and behind the third ventricle, beneath the posterior border of the corpus callosum.

The two anterior are called the *nates*, the two posterior the *testes*. The *brachia* (anterior and posterior) are two white cords connecting them with the optic thalamus and beginning of the optic tracts.

The *processus a cerebello ad testes* connect them with the cerebellum.

To the outer side of the optic lobes are two small masses called the *corpus geniculatum externum* and *internum*.

The *pineal gland*, or *epiphysis cerebri*, is a small, reddish, conical body resting upon and between the nates. It represents the rudiment of a median eye of certain extinct lizards and amphibia (Spencer), well marked in Hatteria. It is attached to the cerebrum by its two peduncles, and is held in position by a fold of the pia mater. It contains a cavity, filled with a viscid fluid and secretory matter composed of phosphates of lime, magnesia, and ammonia—the *acervulus cerebri*.

THE INTERNAL STRUCTURE OF THE MEDULLA OBLONGATA.

The anterior and lateral pyramidal tracts of the cord are continued into the medulla oblongata as the pyramids. The lateral pyramidal tracts decussate in the lower part of the medulla.

The anterior ground bundle is continued upward into the medulla as the posterior longitudinal bundle. It lies behind the pyramids in the medulla.

The sensory columns of the cord (Goll and Burdach) are continued into the medulla oblongata as the funiculus gracilis and cuneatis. They increase in size and each develops a nucleus: the clava and cuneate nucleus, respectively. These fibres partly form the restiform bodies.

The decussation of the sensory fibres takes place at a higher plane than that of the motor fibres. It is also called the decussation of the fillet and it consists of the decussating fibres derived from the clava and the cuneate nucleus. These fibres are called deep arcuate fibres. After decussating the fibres are continued upward behind the pyramids, displacing backwards the posterior longitudinal bundle.

In the medulla on cross-section are seen the olivary bodies, which contain the dentate nuclei.

The restiform bodies, or inferior cerebellar peduncles are formed by the direct cerebellar tract, the posterior superficial arcuate fibres, the anterior superficial arcuate fibres, and the cerebello-olivary fibres.

The formatio reticularis is seen behind the pyramids and the olivary bodies in the medulla oblongata. It is composed of the deep arcuate fibres, fibres of Gower's tract, and the antero lateral ground bundle.

The gray matter of the cord is continued into the medulla. The anterior horns are cut off and displaced by the decussation of the lateral pyramidal tract and the posterior horns are displaced outward by the increase in size of the posterior sensory tracts. The latter are known as the nucleus of Rolando and are capped by the substantia gelatinosa Rolandi.

The central canal is expanded into the fourth ventricle. The gray matter forms nuclei for the cranial nerves in the floor of the fourth ventricle.

THE INTERNAL STRUCTURE OF THE PONS VAROLII.

On cross-section the pons is seen to consist of a dorsal *tegmental* part, and a ventral part, or *crusta.*

The *crusta* is composed of *transverse* fibres (fibres from the cerebellum to the pons and from the nucleus pontis to the cerebellum), which go to form the *middle cerebellar peduncles; longitudinal fibres,* which belong to the pyramidal tracts, much scattered; and *gray matter,* which here forms a nucleus called the *nucleus pontis.*

The *tegmentum* of the pons contains a thick layer of *gray matter,* which forms the floor of the fourth ventricle, and from which cranial nerves take their origin; formatio reticularis, which is the continuation upward of the same from the cord; the superior olivary nucleus; the posterior longitudinal bundle; the fillet; the superior cerebellar peduncle; and the corpus trapezoides.

The fillet occupies a position between the crusta and tegmentum, and to differentiate it from a tract that makes its appearance above the nucleus of the third nerve is called the mesial fillet.

The other tract is named the lateral fillet.

The *lateral fillet* is composed of longitudinal fibres which take origin from the nucleus of the eighth cranial nerve (cochlearis) of the same side, from that of the opposite side, and from the superior olive. They end in the inferior quadrigeminal body, the internal geniculate body, and a few in the superior quadrigeminal body.

The mesial fillet has been described. It takes its origin in the medulla from the cuneate and gracile nuclei of the opposite side. Some of its fibres end in the superior quadrigeminal body, but the remainder pass through the subthalamic tegmental region into the posterior part of the lateral nucleus of the optic thalamus. Some end here, while some are continued through the thalamus, enter the corona radiata, and pass to the posterior central gyrus of the Rolandic region.

THE STRUCTURE OF THE CEREBELLUM.

On section the gray matter of the cerebellum is found to occupy the cortex; to its arborescent appearance the term *arbor vitæ* has been applied.

The white matter of each hemisphere contains a nucleus of gray matter: the corpus dentatum.

The middle peduncles connect the cerebellum with the pons.

The inferior peduncles, or restiform bodies, connect the medulla and cord with the cerebellum.

The superior peduncles connect the cerebellum with the cerebral cortex. After decussating some of the fibres pass to the red nucleus in the tegmentum of the crura cerebri; others pass through the optic thalamus to end in the Rolandic region, and some end in the optic thalamus.

The cerebellar cortex consists of two layers: an outer, *molecular* layer, and an inner, *granular layer*. Between these two layers is a single layer of large cells, the cells of Purkinje.

THE STRUCTURE OF THE MIDBRAIN.

The midbrain consists of a dorsal part, the corpora quadrigemina, and a ventral part, the crura cerebri.

It is tunneled by the aqueduct of Sylvius, which connects the fourth ventricle with the third ventricle.

The upper end of the crura cerebrisis encircled by the optic tract.

On section the crura cerebri show a ventral and lateral portion,—the tegmentum,—and a dorsal portion, the lamina quadrigemina. The ventral portion contains the *substantia nigra*. The fissure of Sylvius is surrounded by gray matter, from which the third, fourth, and a portion of the fifth cranial nerves take origin.

The inferior quadrigeminal bodies receive the fibres of the lateral fillet.

The superior quadrigeminal bodies consist of four strata: stratum zonale, stratum cinereum, stratum opticum, and stratum lemnisci. The mesial fillet in part ends in the latter.

The lateral fillet also gives a few fibres.

Some fibres from the occipital lobe and fibres from the retina, conveyed by the superior brachium, end in the superior quadrigeminal bodies.

The superior cerebellar peduncles have been described; they connect the cerebellum with the cerebral cortex.

The *red nucleus* is found in the tegmentum. Some of the fibres of the superior cerebellar peduncles end there.

The posterior longitudinal bundle lies in the tegmentum and is the continuation upward of the tract of the same name in the medulla and pons. It is connected with the nuclei of the motor nerves of the muscles of the eyeball.

The lateral fillet is continued upward from the pons in the tegmentum. Its connections with the superior olivary nuclei and the nuclei of the eighth nerve have been described.

The mesial fillet likewise is continued upward from the pons in the tegmentum of the crura. The course of the fibres has been described.

The crusta of the crura contains the pyramidal fibres and the cortico-pontine fibres.

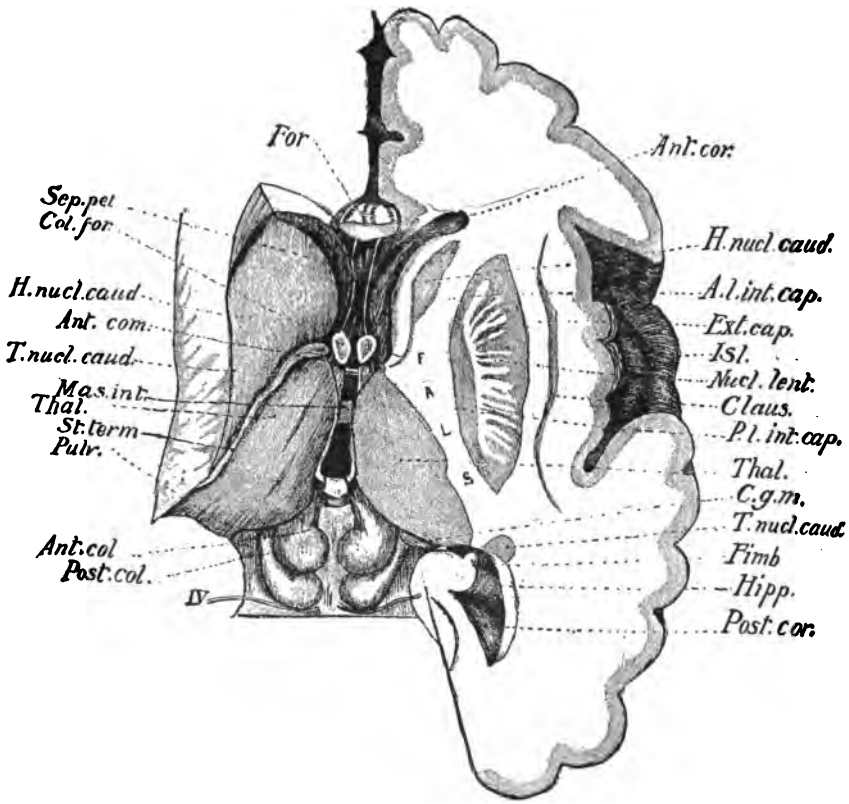


FIG. 138.

Interior of mesencephalon. For., fornix; Sep. pel., septum pellucidum; Col. for., column of fornix; H. nucl. caud., head of nucleus caudatus; Ant. com., anterior commissure; T. nucl. caud., tail of nucleus caudatus; Mas. int. massa intermedia; Thal., thalamus; St. term., stria terminalis; Pulv., pulvinar; Ant. col., anterior colliculus; Post. col., posterior colliculus; IV, Trochlear nerve; Ant. cor., anterior cornu of lateral ventricle; A. l. int. cap., anterior limb of internal capsule; Ext. cap., external capsule; Isl., island of Reil; Nucl. lent., nucleus lentiformis; Claus., claustrum; P. l. int. cap., posterior limb of internal capsule; Hipp., hippocampus; Post. cor., posterior cornu of lateral ventricle. (*After Landois.*) (*Whitehead.*)

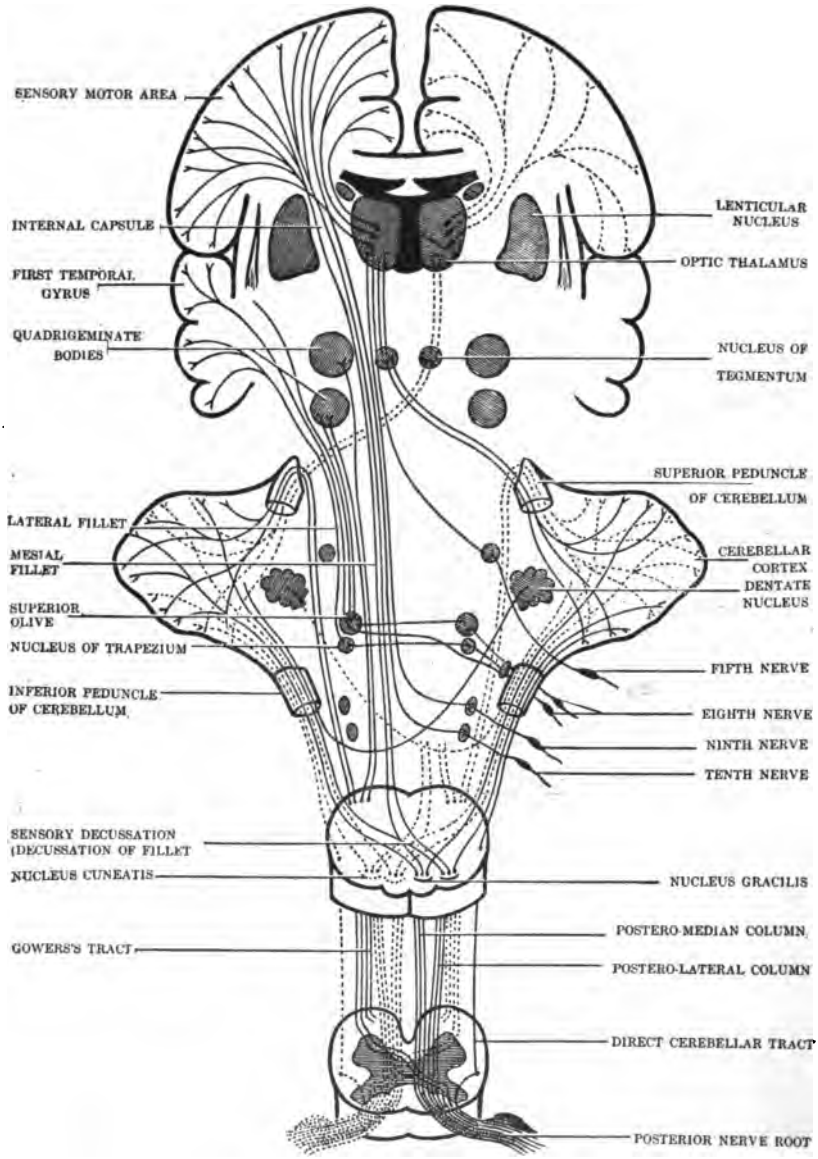


FIG. 139.

Diagram of sensory tracts from spinal cord to brain (original).

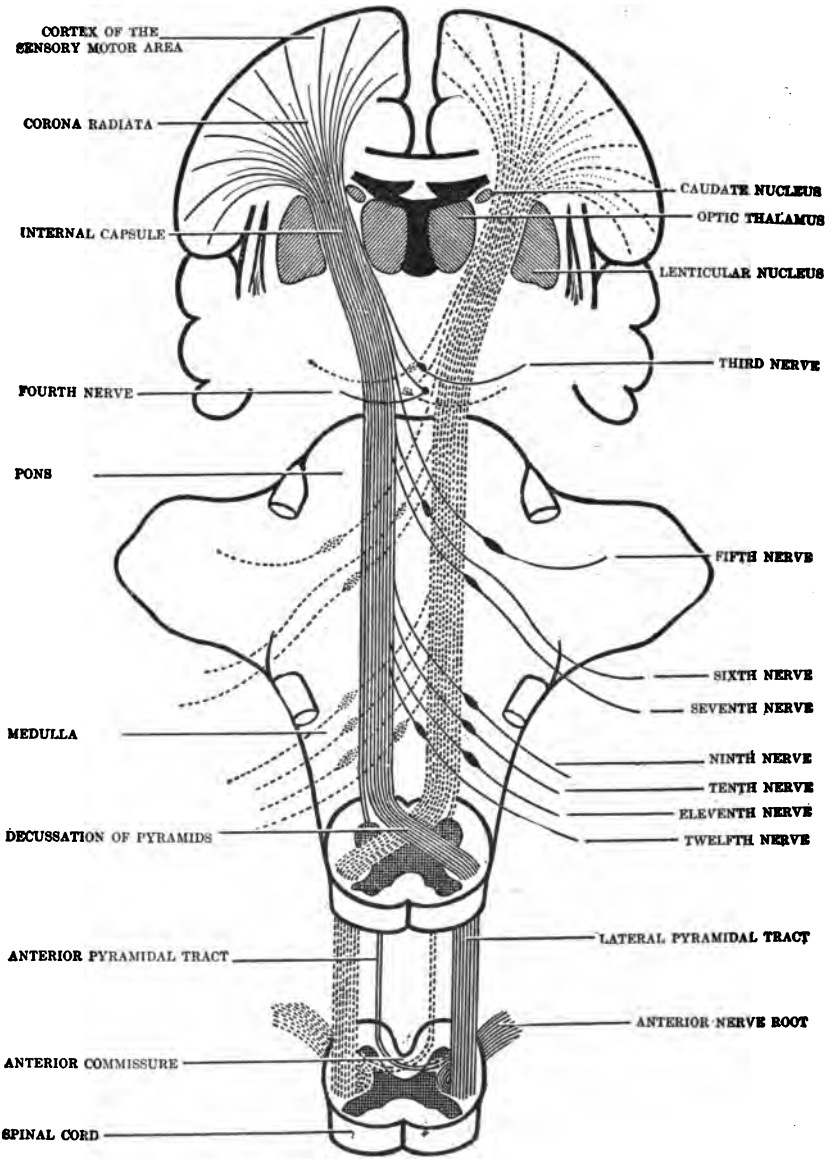


FIG. 140.

Diagram of motor tracts from brain to spinal cord (original).

THE STRUCTURE OF THE CEREBRUM.

On cross-section the cut brain surface shows an outer gray cortex and the inner white matter and cavities, one to each hemisphere: the lateral ventricles. The white matter contains

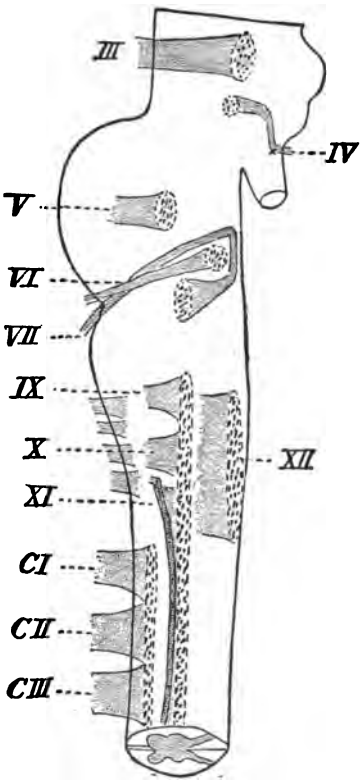


FIG. 141.

Scheme of the nuclei and root-fibres of the cranial nerves.
(After Edinger.) ***(Whitehead.)***

certain masses of gray matter: the optic thalami and the corpora striata, which latter are on each side of the brain divided into the caudate and lenticular nuclei by the internal capsule. Between the optic thalamus and caudate nucleus on the inside and the lenticular nucleus on the outside passes the broad band of

white fibres known as the internal capsule. As it nears the cortex the fibres spread out. To this is given the name corona radiata. Between the lenticular nucleus and the cortex of the island of Reil is seen a thin sheet of gray matter: the claustrum.

The white matter between the claustrum and the cortex is known as the external capsule. On horizontal section of the brain the internal capsule is seen to be bent upon itself, the interval between the optic thalamus and the caudate nucleus. This bend is called the genu. One-third of the capsule lies in front of this bend, and is called the anterior limb; the portion behind the genu is called the posterior limb.

The anterior limb, contains (1) fibres that pass from the optic thalamus to the lenticular and caudate nucleus, (2) fibres that pass from the optic thalamus to the cortex of the frontal lobe, and (3) fibres that pass from the cortex of the frontal lobe to pass to the nucleus pontis.

The posterior limb contains (1) a continuation upward of a portion of the mesial fillet and the superior cerebellar peduncles, (2) the pyramidal tracts or motor fibres from the Rolandic area, (3) the fibres of the optic radiation, (4) the fibres of the auditory radiation, and (5) the temporo-pontine tract.

The opposite sides of the brain are connected by the commissural fibres. Convolutions on the same side are connected by association fibres. Projection fibres are those which unite the cerebral cortex with nuclei in lower levels. They pass principally through the corona radiata.

The cerebral cortex consists of four layers: the stratum zonale, the layer of small pyramidal cells, the layer of large pyramidal cells, and the layer of polymorphic cells.

CRANIAL NERVES.

The cranial nerves consist of twelve pairs, as follows:—

1. Olfactory,
2. Optic,
3. Motores oculorum,
4. Pathetici,
5. Trifacial,
6. Abducentes,
7. Facial (portio dura),
8. Auditory (portio mollis),
9. Glosso-pharyngeal,
10. Pneumogastric (vagus, or par vagum),
11. Spinal accessory,
12. Hypoglossal.

1. OLFACTORY NERVE, special nerve of smell. A number of nerves (20) arise from the olfactory bulb or lobe of the brain. *Superficial origin* of the tract by roots: internal from frontal lobe, middle or gray root from the olfactory tubercle between

the other roots of the tract, and external from the middle lobe; *deep origin,* from gyrus fornicatus, uncinate gyrus of limbic lobe; *course,* roots unite, pass forward, and form bulbus olfactorius (from this the olfactory nerves are given off); *exit,* foramina of cribriform plate of ethmoid; *distribution,* by three

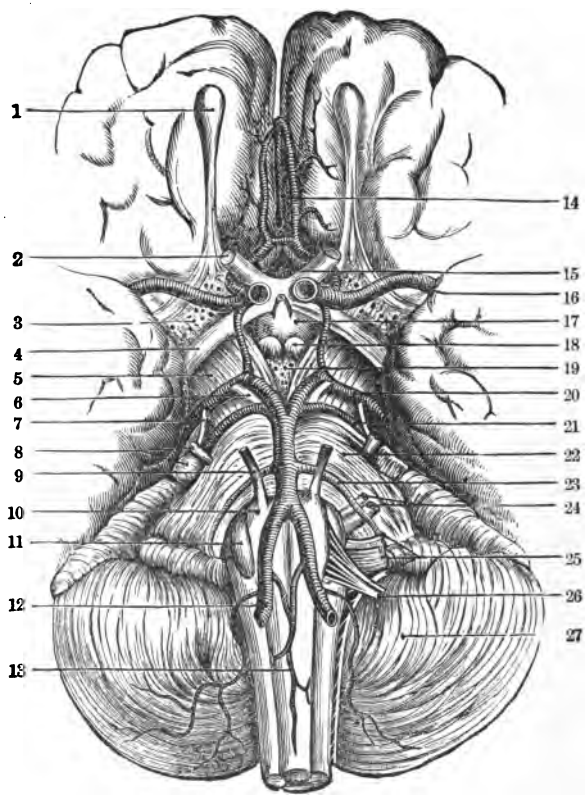


FIG. 142.

Base of brain and cranial nerves: 1, olfactory bulb; 2, optic nerves; 4, tractus opticus; 5, crus cerebri; 6, third pair of nerves; 7, fourth pair of nerves; 8, fifth pair of nerves; 9, sixth pair of nerves; 10, pyramid; 11, olivary body; 22, pons Varolii; 24, seventh and eighth pairs of nerves; 25, ninth, tenth, and eleventh pairs of nerves; 26, twelfth pair of nerves; 27, cerebellum.

groups to mucous (Schneiderian) membrane of nares, inner to septum nasi, middle to roof of nasal fossa, outer to superior turbinated bone.

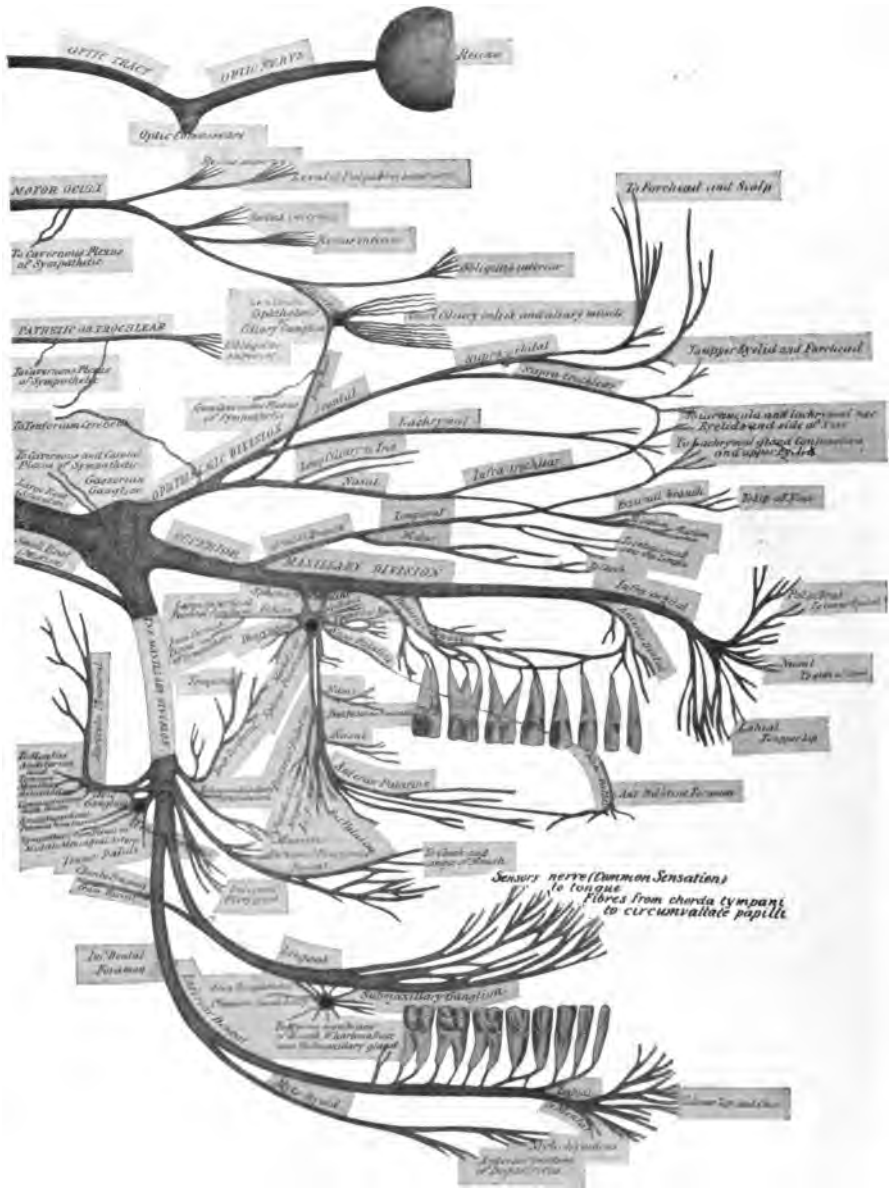


FIG. 143.

Optic, oculomotor, trachlear, and trifacial nerves.

2. OPTIC NERVE, special nerve of sight; *superficial origin,* optic chiasma or commissure formed by union of the optic tracts. The commissure and tracts contain intercerebral fibres, the cerebro-retinal fibres of the same side, and the cerebro-retinal fibres of opposite sides. *Deep origin,* the optic tracts arise from optic thalamus, the upper corpora quadrigemina, and corpora geniculati; *course,* diverge and pass forward; *exit,* optic foramen; *distribution,* to ganglion cells in the retina.

3. MOTOR OCULI, motor nerve; *superficial origin,* inner surface of crus cerebri; *deep origin,* from the oculo-motor nucleus in floor of aqueduct of Sylvius; *course,* from inner side of crus cerebri passes forward, descends along external wall of cavernous sinus; *exit,* sphenoidal fissure between two heads of external rectus muscle; *distribution,* by superior and inferior divisions, to all the ocular muscles (including the iris) *except* the external rectus and superior oblique.

4. TROCHLEAR (pathetic), motor nerve; *superficial origin,* from valve of Vieussens, on outer side of crus cerebri; *deep origin,* from floor of aqueduct of Sylvius; *course,* outer side of crus cerebri, through outer wall of cavernous sinus; *exit,* sphenoidal fissure; *distribution,* to superior oblique muscle.

5. TRIFACIAL, or TRIGEMINUS, common sensation, taste and motion; *superficial origin,* by two roots, like a spinal nerve, from the side of the pons Varolii; *deep origin,* the motor root, from (1) a nucleus in the floor of the aqueduct of Sylvius (descending motor root), and (2) from a nucleus in the pons (these join to form the motor root); the sensory root ends in two terminal nuclei—(1) the sensory nucleus of the fifth nerve in the pons and (2) the substantia gelatinosa Rolandi in the pons, medulla, and the spinal cord as far down as the second cervical nerve; *course,* passes forward to apex of petrous portion of temporal bone, where the sensory root enters Gasserian ganglion, the motor passing beneath, and later joins a branch of the ganglion. It divides into three branches—ophthalmic, superior maxillary, and inferior maxillary; *exit,* ophthalmic by sphenoidal fissure, superior maxillary by foramen rotundum, inferior maxillary by foramen ovale.

Ophthalmic nerve, entirely sensory, supplies lachrymal gland, upper eyelid, skin and muscles of forehead, eyebrow, nose, eyeball (ciliary muscle, iris, etc.), mucous membrane of eyelids and nose, and the ciliary ganglion.

Its branches are:—

Lachrymal, **Frontal,** **Nasal.**

Superior maxillary nerve, entirely sensory also; supplies sensation to upper jaw, teeth, hard and soft palates, tonsils, gums, antrum of Highmore, muscles, skin and mucous membrane of lower eyelid, muscles and skin of cheeks and upper lip, and mucous membrane of floor of nares.

Its branches are:—

Orbital,	Middle dental,	Palpebral,
Spheno-palatine,	Anterior dental,	Nasal,
Posterior dental,		Labial.

Inferior maxillary nerve consists of two portions: anterior, or motor, and posterior, or sensory, having a threefold function, because one of its branches, the lingual, is joined by the chorda tympani nerve (given off from the facial nerve), which conveys gustatory fibres to the anterior two-thirds of the tongue. It supplies motion to all the muscles of mastication (except to buccinator), anterior belly of digastric, and mylo-hyoideus; sensation to skin of ear, lower part of face, lower lip, and tongue. Its branches are:—

Anterior Portion.	*Posterior Portion.*
Masseteric,	Auriculo-temporal,
Deep temporal (2),	Inferior dental,
Buccal,	Lingual.
Pterygoid (2).	

The fifth nerve has four ganglia connected with it:—

(a) Ophthalmic, or lenticular;
(b) Spheno-palatine, or Meckel's;
(c) Otic, or Arnold's;
(d) Submaxillary (*vide* Sympathetic System).

6. ABDUCENS, motor; *superficial origin,* pyramidal body and pons Varolii; *deep origin,* floor of fourth ventricle; *course,* passes forward in cavernous sinus; *exit,* sphenoidal fissure; *distribution,* to external rectus muscle.

7. FACIAL, motor nerve; *superficial origin,* lateral tract of medulla and pons Varolii; *deep origin,* from a nucleus in the pons, deeply placed, from which the fibres ascend close to the floor of the fourth ventricle, where they form the eminentia teres arch over the nucleus of the sixth nerve, and then emerge (this nerve carries some sensory fibres, probably gustatory fibres from the tongue, through the chorda tympani nerve to the pass intermedia, near the nucleus of the ninth nerve); *course,* forward and outward, through internal auditory meatus, aquæductus Fallopii,

and inner wall of tympanum; *exit,* stylo-mastoid foramen; *distribution,* to muscles of expression, buccinator, and platysma, posterior belly of digastric, stylo-hyoid, attrahens and retrahens aurem muscles, to laxator tympani and stapedius through tympanic branch, dorsal surface of tongue through chorda tympani, and levator palati, and azygos uvulæ muscles through Vidian. In its course through the temporal bone it communicates with many important nerves; in the internal auditory meatus, with auditory; in aquæductus Fallopii, with otic ganglion, by the small petrosal; Meckel's ganglion, by the large petrosal nerve; the sympathetic of the great meningeal, by the external petrosal nerve; and at its exit from the stylo-mastoid foramen, with the glosso-pharyngeal, pneumogastric, auriculo-temporal, auricularis magnus, and the carotid plexus. Its branches are:—

In Aquæductus Fallopii.

Tympanic,
Chorda tympani.

After Exit from Stylo-mastoid Foramen.

On the Face.

- Temporo-facial, { Temporal, Molar, Infraorbital.
- Cervico-facial, { Buccal, Supramaxillary, Inframaxillary.
- Posterior auricular,
- Stylo-hyoid,
- Digastric.

8. AUDITORY, special nerve of hearing, consists of two portions—(1) cochlear, or auditory portion, and (2) vestibular, or fibres whose function is to localize position.

The former pass from the cochlea to the (1) accessory auditory nucleus in the medulla, and (2) to the lateral acoustic tubercle in the medulla. These fibres, by means of the lateral fillet, communicate with the inferior corpora quadrigemina.

The vestibular fibres pass from the vestibule to the external and internal dorsal nuclei in the floor of the fourth ventricle, and by the sensory decussation to the nucleus cuneatus.

Superficial origin, from groove between olivary and restiform bodies; *course,* winds around restiform body, and passes forward to internal auditory meatus, with the facial; *distribution,* to internal ear by two branches:—

Vestibular, and Cochlear (*vide* Ear, p. 370).

9. GLOSSO-PHARYNGEAL, or ninth, nerve of motion, common sensation, and taste; *superficial origin,* from medulla oblongata, between olivary and restiform bodies; *deep origin,* from motor

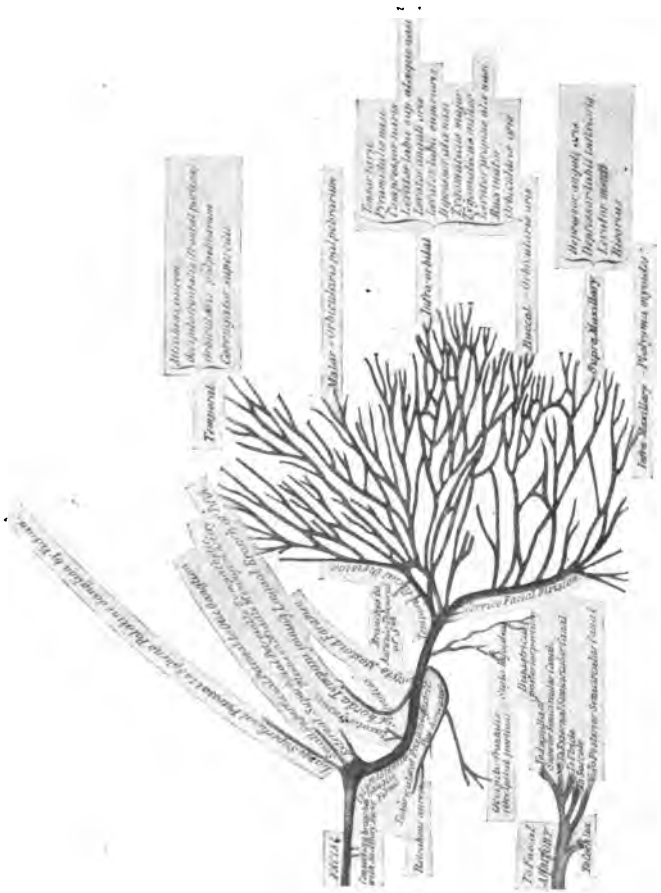


FIG. 144.

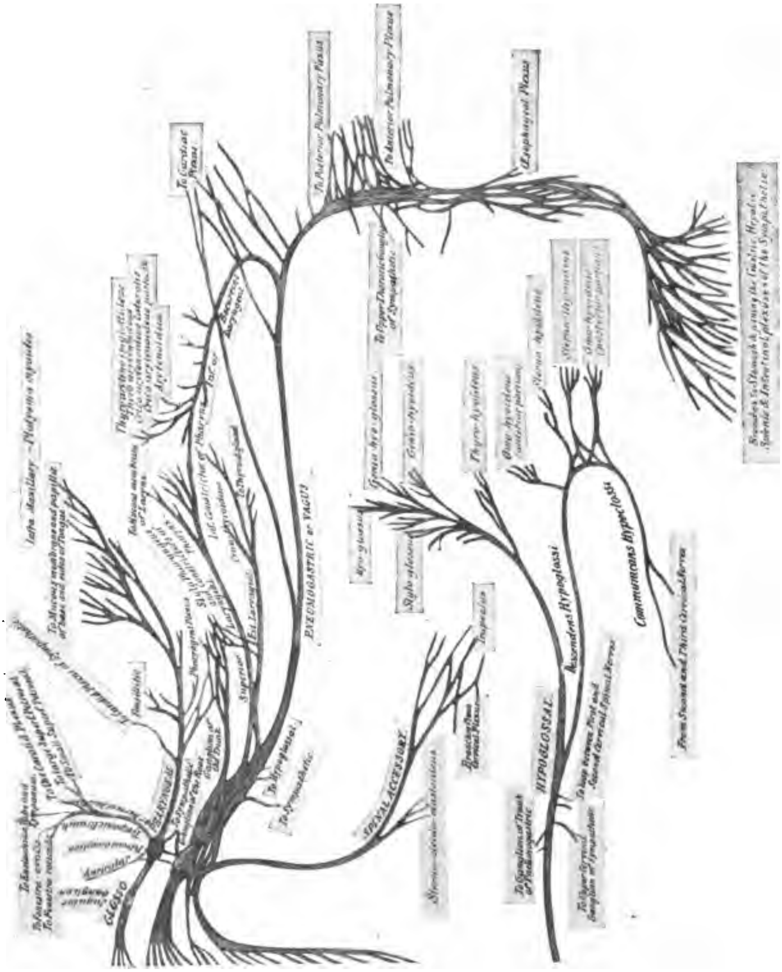

PNEUMOGASTRIC or VAGUS
SPINAL ACCESSORY
HYPOGLOSSAL
Communicans Hypoglossi
Descendens Hypoglossi
Œsophageal Plexus
To Cardiac Plexus
To Posterior Pulmonary Plexus
To Anterior Pulmonary Plexus
Sterno-cleido-mastoideus
Trapezius
Thyro-hyoideus
Genio-hyo-glossus
Genio-hyoideus
Stylo-glossus
Hyo-glossus
Sterno-hyoideus
Sterno-thyroideus
From Second and Third Cervical Nerves

Fig. 145.

and sensory gray nuclei in floor of fourth ventricle; *course,* passes outward across flocculus; *exit,* jugular foramen, in separate sheath, in front of pneumogastric and spinal accessory, having two gangliform enlargements upon it—jugular and petrosal, petrous, or ganglion of Andersch; *distribution,* to mucous membrane of fauces, tonsil, pharynx, and middle ear, muscles of the pharynx, and special sense of taste to the base and sides of the tongue. Its branches are:—

Tympanic (Jacobson),	Pharyngeal branches,
Carotid branches,	Tonsillar branches,
Muscular branches,	Lingual branches.

10. PNEUMOGASTRIC (vagus, or par vagum), tenth nerve, motor and sensory; *superficial origin,* from groove between olivary and restiform bodies by a dozen filaments; *deep origin,* from nuclei in floor of fourth ventricle; *course,* passes outward across the flocculus; *exit,* jugular foramen in a common sheath with the spinal accessory nerves; *distribution* (not definitely known), motor nerve to the organs of respiration and voice, and a motor and sensory nerve to heart, œsophagus, pharynx, and stomach. Its branches are:—

Auricular (Arnold's),	Thoracic cardiac,
Pharyngeal,	Anterior pulmonary,
Superior laryngeal,	Posterior pulmonary,
Recurrent laryngeal,	Œsophageal,
Cervical cardiac,	Gastric.

It also communicates with the left hepatic sympathetic plexus.

11. SPINAL ACCESSORY, eleventh, motor nerve; *superficial origin,* from lateral tract of medulla and spinal cord as low as sixth cervical nerve; *deep origin,* spinal portion from anterior horn of gray matter, accessory portion from gray nucleus in floor of fourth ventricle; *course,* the spinal portion enters the skull through the foramen magnum, and joins the accessory portion in the jugular foramen; *exit,* jugular foramen in sheath with the pneumogastric; *distribution,* to sterno-cleido-mastoid and trapezius muscles, communicating with the cervical plexus and pharyngeal and laryngeal branches of pneumogastric.

12. HYPOGLOSSAL, or twelfth nerve, motor nerve of tongue; *superficial origin,* from groove between olivary and pyramidal bodies by about a dozen filaments; *deep origin,* from gray nucleus at lowest part of floor of fourth ventricle; *exit,* anterior condyloid foramen; *distribution,* to the omo-hyoid (both bellies), sterno-hyoid, sterno-thyroid, thyro-hyoid, and muscles of the

tongue—styloglossus, hyoglossus, genio-hyoid, genio-hyoglossus, communicating with the pneumogastric, sympathetic, first and second cervical, and gustatory nerves. Its branches are:—

Descendens hypoglossi,	**Muscular,**
Thyro-hyoid,	**Meningeal.**

MEMBRANES OF THE CORD.—The membranes of the spinal cord are three—the dura mater, arachnoid, and pia mater.

Dura mater is a loose fibrous sheath, continuous with the dura of the brain, and from which it differs in not inclosing the venous sinuses, not dipping into the fissures of the cord, and not being adherent to the bony canal. From the latter it is separated by the venous plexuses and some connective tissue.

It extends the whole length of the canal, from the foramen magnum (to which it is attached) to the top of the sacrum.

Arachnoid is a delicate serous sac, continuous above with the cerebral arachnoid, inclosing the pia mater, from which it is separated by an interval—the *subarachnoidean space.* It is filled with the *cerebro-spinal fluid.* The outer surface of the arachnoid is in contact with the dura, the space between them being called the *subdural* space.

Pia mater is a fibrous membrane, closely adhering to the cord and forming its neurilemma. Over the anterior median fissure it is strengthened by a fibrous band—the *linea splendens*—and laterally has the *ligamentum denticulatum.* It terminates below the cord as the *filum terminale*—a slender filament.

THE SPINAL CORD.

The spinal cord (medulla spinalis) is the elongated portion of the cerebro-spinal axis contained in the spinal canal. Its length is about sixteen to eighteen inches, extending from the medulla above to the lower border of the first lumbar vertebra below, where it terminates in the *cauda equina* by a slender prolongation of gray substance, called the *conus medullaris.*

It presents two enlargements, the upper or cervical, extending from the third cervical to the second dorsal vertebra, and the lower about the position of the second or third dorsal vertebra. It is divided into two lateral halves by the *anterior* and *posterior median fissures,* united in the centre by the commissure. The lateral portions are again subdivided by the *antero-lateral* and *postero-lateral fissures* into the *anterior lateral* and *posterior lateral columns,* and posteriorly a narrow fissure separates the

posterior median column from the posterior median fissure. The gray substance occupies the centre of the cord, and is arranged into two crescentic masses connected together by the gray commissure. The *posterior horn* forms the *apex cornu,* from which arises the posterior root of the spinal nerves. The *anterior horn* is thick and short, and affords origin to the anterior root of the nerve. The gray commissure contains throughout its whole length a minute canal—the *central canal,* or *ventricle of the cord,* continuous above with the fourth ventricle.

SPINAL NERVES.

The spinal nerves consist of thirty-one pairs, arranged in the following order: cervical, eight pairs; dorsal, twelve pairs; lumbar, five pairs; sacral, five pairs; coccygeal, one pair.

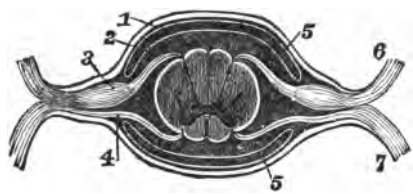


FIG. 146.

Section of spinal cord and membranes: 1, dura mater; 2, arachnoid membrane; 3, ganglion on posterior root; 4, anterior root of spinal nerve; 5, 5, subarachnoid space; 6, posterior branch of spinal nerve; 7, anterior branch of spinal nerve.

Each of the spinal nerves arises by two roots, an anterior or motor and a posterior or sensory. The fibres of the anterior root arise from the antero-lateral columns, originating deeply in the gray matter of the cord. The posterior roots arise at the postero-lateral fissure, also originating deeply in the gray matter of the cord. The posterior roots have each a ganglion developed upon it—except sometimes the first cervical. These roots unite and the nerve then subdivides into two branches, both having motor and sensory fibres. The posterior branches are smaller and unimportant; they supply the skin and muscles of the back.

The anterior branches supply the neck, front and sides of the trunk, and the extremities.

CERVICAL PLEXUS.—The cervical plexus is formed by the anterior divisions of the first to the fourth cervical nerves. It is covered by the sterno-mastoid muscle, and rests upon the

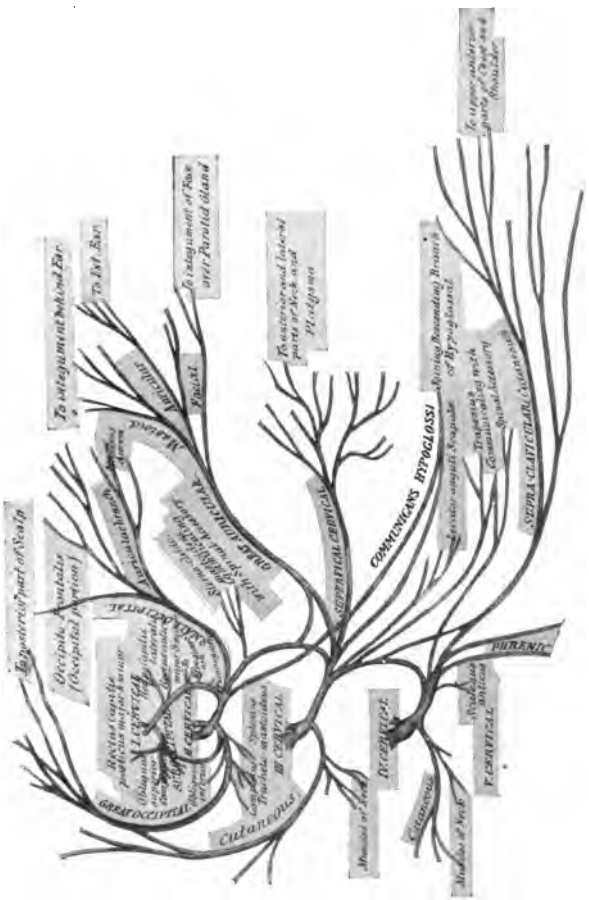

To integument behind Ear
To Ext. Ear
To integument of Face over Parotid gland
To anterior and lateral parts of Neck and Integument
Occipito-frontalis
Occipito-frontalis (Occipital portion)
Integument part of Scalp
Auricular
Facial
Deep Auricular
Superficial Cervical
Communicans Hypoglossi
Sterno-mastoid & Trapezius
Trapezius
Sterno-mastoid
Cutaneous
Muscles of Head
Muscles of Neck
Sternal
Acromial
Supra-clavicular
Phrenic

FIG. 147.

scalenus medius and levator anguli scapulæ muscle. It gives off:—

Superficial.

Superficialis colli,	Occipitalis minor,
Auricularis magnus,	Supraclavicular.

Deep.

Communicating,	Communicantes hypoglossi,
Muscular,	Communicating,
Phrenic,	Muscular.

The *phrenic nerve,* or *internal respiratory of Bell,* is derived from the third and fourth cervical nerves, with a branch from the fifth. It descends into the chest between the subclavian artery and vein, between the pericardium and the pleura, to the diaphragm, to which it is distributed. The course of the two nerves differs in the thorax (*vide* Mediastinum).

THE BRACHIAL PLEXUS is formed by the anterior branches of the four lower cervical and the first upper dorsal nerves—the fifth, sixth, and seventh forming one cord, and the eighth cervical and first dorsal another cord. Below the line of the clavicle, both these trunks divide, the adjacent cords of the two upper uniting to form the posterior, and the remaining cords forming the outer and inner cords respectively, receiving their names from their relative position to the subclavian artery. Each of these cords again bifurcates, the adjacent divisions at the outer ending of the cords uniting over the artery to form the median nerve, the other divisions forming the musculo-cutaneous, ulnar, circumflex, and musculo-spiral, the two latter being the divisions of the posterior cord. Its branches are:—

Above the clavicle:—

Communicating, arises from the fifth cervical, and passes to the phrenic;

Muscular, supply the scaleni, rhomboidii, longus colli, and subclavius;

Posterior thoracic, long *thoracic,* or *external respiratory of Bell,* arises by five roots from the fifth to seventh cervical nerves, which unite within the scalenus medius muscle and descend to supply the serratus magnus;

Suprascapular, passes beneath the trapezius, through the suprascapular notch, to supply the shoulder-joint and supra-spinatus muscle.

Below the clavicle:—

The *anterior thoracic nerves* are two in number: an external branch from the outer cord and an internal from the inner cord.

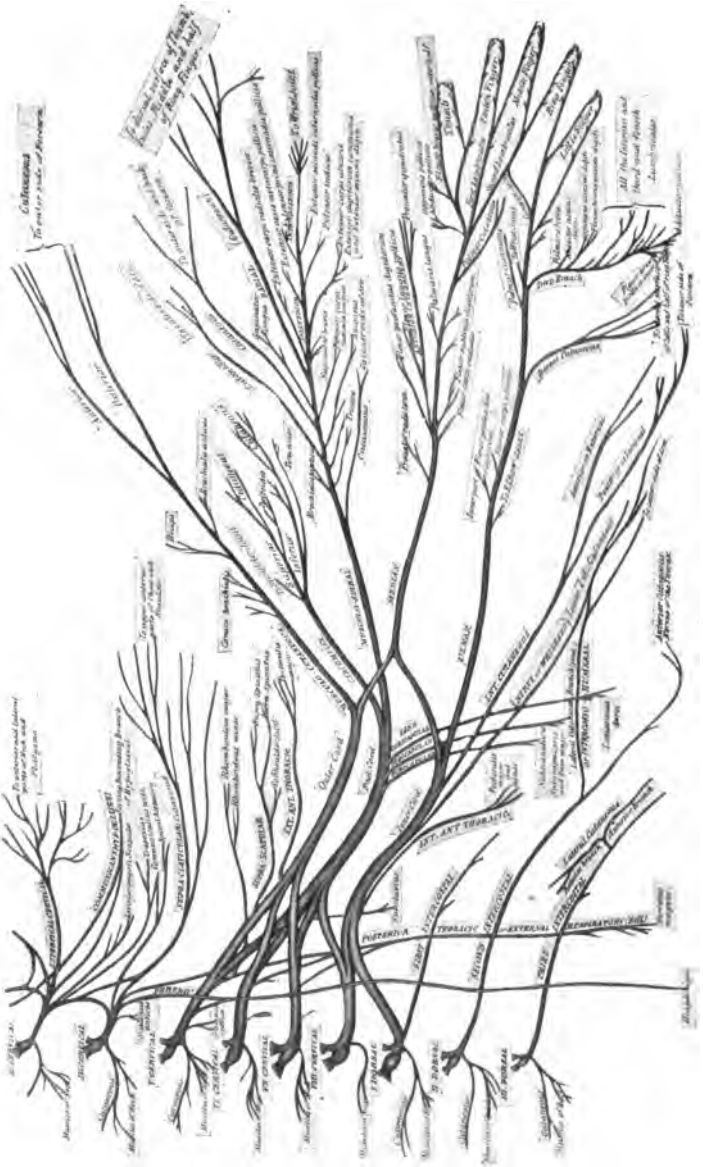


FIG. 148.

The former supplies the pectoralis major and the latter the pectoralis minor, and sending branches to the pectoralis major.

The *subscapular nerves* are three in number. The upper subscapular supplies the subscapular muscle, the lower subscapular nerve supplies the teres major and subscapularis, the middle or long subscapular supplies the latissimus dorsi.

The *circumflex nerve* accompanies the posterior circumflex artery, passing through the space formed between the teres major, teres minor, and long head of the triceps to supply the shoulder-joint and skin over the shoulder and the neighboring muscles. It gives off two branches, an upper and a lower branch.

The *musculo-cutaneous nerve* pierces the coraco-brachialis muscle and descends the arm to supply the brachialis anticus, biceps, coraco-brachialis, and the skin of the forearm. At the outer border of the tendon of the biceps, above the elbow, it becomes superficial and divides into two branches—the anterior descending the radial side of the forearm to the wrist and supplying the skin of that part, the posterior branch descending the back part of the radial side of the forearm to the wrist to supply that part.

The *internal cutaneous nerve* descends the inner side of the arm together with the basilic vein to about its middle, where it becomes cutaneous, supplying the skin of this region. It has an anterior and a posterior branch.

The *lesser internal cutaneous nerve of Wrisberg* is derived from the inner cord, and receives filaments from the eighth cervical, first dorsal, and the intercosto-humeral nerve, and is distributed to the skin on the inner side of the arm.

The *median nerve,* formed by a root from the outer and inner cord of the brachial plexus, descends the arm, crossing the brachial artery from its outer to its inner side at the bend of the elbow. Its branches are:—

Muscular branches, supply all the superficial anterior muscles except the flexor carpi ulnaris;

Anterior interosseous, supplies all the deep anterior muscles except the inner half of the flexor profundis digitorum;

Palmar cutaneous, crosses above the annular ligament, divides into two branches to supply the ball of the thumb and the palmar surface of the hand;

Branches to the *muscles* of the *thumb,* supplies the opponens, outer head of the small flexor, and the abductor;

Digital branches, supply both sides of the thumb, index and middle and the radial side of the ring finger.

The *ulnar nerve* descends the inner side of the axillary artery to the middle of the arm, where it crosses the internal head of the triceps, and accompanies the inferior profunda artery to

the elbow, where it passes between the heads of the flexor carpi ulnaris. Its branches are, in the forearm:—

Articular (elbow), supplies the elbow-joint;
Muscular, to inner half of the deep flexors and flexor carpi ulnaris;
Cutaneous, supplies the skin of the palm;
Dorsal cutaneous, supplies both sides of the little finger and the ulnar side of the ring finger;
Articular (wrist), supply the wrist-joint.

In the hand:—

Superficial palmar, supplies the skin of both sides of the little and the ulnar side of the ring finger and palmaris brevis muscle;
Deep palmar, supplies the interossei, lumbricales, adductor pollicis, and inner head of flexor brevis pollicis.

The *musculo-spiral* nerve, derived from the posterior cord of the brachial plexus, descends the arm in front of the teres major and latissimus dorsi muscle, accompanies the superior profunda artery through the musculo-spiral groove to the outer side of the elbow, between the supinator longus and the brachialis anticus, where it divides into the radial and posterior interosseous nerves. Its branches are:—

Muscular, supply the supinator longus, external carpi radialis longior, triceps, anconeus, and brachialis anticus;
Radial, descends in the course of the radial artery to three inches above the wrist, where it becomes superficial, and supplies the adjoining sides of the thumb and index, index and middle, middle and ring fingers.
Cutaneous, supply the outer side of the arm, elbow, and radial side of forearm and wrist;
Posterior interosseous, passes through the supinator brevis muscle, and supplies, as it descends, all the posterior brachial and radial muscles, except those supplied by the muscular branches of the ulnar. It has a ganglion upon it.

Dorsal Nerves.—The posterior divisions of the dorsal nerves subdivide into the external and internal branches to supply the muscles of the skin of the back. The anterior divisions of the dorsal nerves *(intercostal nerves)*, twelve in number, supply the walls of the abdomen and thorax. They are divided into two sets—the six upper, distributed for the most part to the walls of the chest, and the six lower, to the walls of the chest and abdomen. The upper six dorsal nerves run between the two sets of the intercostal muscles, accompanied by the intercostal vessels, to supply the skin over the front of the chest and the mammæ. Their branches are:—

Lateral cutaneous, divide into two branches, anterior and posterior;
Anterior branches, to the skin of the chest and mammæ principally;
Posterior branches, to the skin over the scapular and lower dorsal regions.

The *first intercostal nerve* is not distributed to the skin, but crosses the axilla under the name of the intercosto-humeral nerve; it joins the brachial plexus. The six lower dorsal nerves have received the name of *lower*, or *abdominal intercostal nerves*, from their distribution. The last dorsal one is of large size, and gives off a branch, the dorsi lumbar nerve, to join the lumbar plexus.

LUMBAR NERVES.—The posterior divisions of the lumbar nerves have the same distribution as the other spinal nerves. The anterior divisions of the upper four lumbar nerves unite to form the lumbar plexus. The fifth, with a branch from the fourth, joins the sacral nerves to form the lumbo-sacral cord.

THE LUMBAR PLEXUS is formed by the communicating loops from the anterior branches of the first four lumbar nerves and a branch from the last dorsal.

Its branches are:—

1. *Ilio-hypogastric,* divides into two branches:—

(a) Iliac branch, supplies the skin of the gluteal region and the oblique muscles of the abdomen;
(b) Hypogastric branch, supplies the skin of the hypogastric region and the oblique muscles.

2. *Ilio-inguinal,* supplies the skin of the inner and upper part of the thigh, the scrotum, and labium (in female).

3. *Genito-crural,* passes through the psoas muscle and divides into two branches:—

(a) Genital branch, follows the spermatic cord to supply the cremaster muscle; in female, supplies round ligament;
(b) Crural branch, descends in the sheath of the femoral vessels to supply the skin in front of the thigh.

4. *External cutaneous* emerges below the anterior superior spine of ilium and divides into:—

(a) Anterior branch, to skin of outer and front aspect of thigh;
(b) Posterior branch, to skin of outer and back aspect of thigh.

5. *Obturator,* follows the brim and outer wall of pelvis to foramen (obturator), which it pierces to enter thigh.

(a) Anterior branch, supplies the femoral artery;
(b) Posterior branch, supplies the adductor muscles;
(c) Articular branch, supplies the synovial membrane of knee-joint.

6. *Accessory obturator,* sends a branch to the hip-joint and one to join the anterior branch of the obturator nerve.

7. *Anterior crural,* the largest branch of the lumbar plexus, descends through the psoas muscle, beneath Poupart's ligament,

into the thigh, where it divides into an anterior or cutaneous branch, and a posterior or muscular branch. It supplies all the muscles and the front of the thigh, excepting the tensor vaginæ femoris, gives branches to the knee, and supplies the skin of the inner side in front of the thigh, and to the leg and foot. Its branches are, from the anterior division:—

(a) Middle cutaneous, to sartorius muscle and skin of front of thigh;
(b) Internal cutaneous, supplies the skin in the inner aspect of the leg;
(c) Long saphenous, or internal saphenous, passes through Hunter's canal, accompanies the internal saphenous vein, to supply the skin of the inner side of the foot.

From the posterior division:—

(a) Muscular, to the muscles of the anterior and lateral aspects of the thigh;
(b) Articular, to the knee-joint.

THE SACRAL NERVES, five in number, divide into anterior and posterior nerves. The four upper sacral nerves, with the fifth lumbar, and a filament from the fourth, the two latter forming the lumbo-sacral cord, together form the *sacral plexus*. It lies upon the anterior surface of the pyriformis muscle, and is separated from the viscera, the sciatic and pudic branches of the internal iliac artery, by the pelvic fascia. Its branches are:—

1. *Muscular,* supply the obturators, gemelli, quadratus femoris, and pyriformis.

2. *Superior gluteal,* supplies the glutei muscles and tensor vaginæ femoris.

3. *Pudic,* accompanies the internal pudic artery, passing out of the great sacro-sciatic foramen, around the spine of the ischium to re-enter the lesser sacro-sciatic foramen. It gives off:—

(a) Inferior hæmorrhoidal, supplies the skin of the anus;
(b) Perineal, follows the course of the superficial perineal artery to supply the perineal structures generally;
(c) Dorsal nerve of the penis, follows the course of the corresponding artery to supply the skin of the glans, prepuce, and penis generally.

4. *Small sciatic,* supplies the skin of the thigh, leg, perineum, and the gluteus maximus muscle. Its branches are:—

(a) Inferior gluteal, to the gluteus maximus;
(b) Internal cutaneous branches, to the skin of the inner and upper part of the thigh, and one branch, the *inferior pudendal,* supplies the skin of the scrotum in the male and labium in the female;

(c) Ascending, cutaneous branches supply the skin over the gluteus maximus.

5. The *great sciatic nerve,* the largest in the body, passes out of the great sacro-sciatic foramen, and descends between the tuberosity of the ischium and the great trochanter to the lower third of the thigh, where it divides into the internal and external popliteal. It gives off:—

(a) Muscular branches, to the muscles on the inner and posterior aspect of the thigh;
(b) Articular branches, to the hip-joint.

The *internal popliteal,* descends through the popliteal space to the arch of the soleus muscle, where it becomes the posterior tibial. It gives off:—

(a) Articular branches, to knee-joint;
(b) Muscular branches, to the muscles on the posterior aspect of the leg;
(c) External, or short saphenous nerve, passes between the two heads of the gastrocnemius muscle, and descends the leg, receiving the communicans peronei branch from the external popliteal, around the outer malleolus to supply the skin of the outer side of the foot.

The *posterior tibial* nerve descends the leg in company with the posterior tibial vessels to below the inner ankle, where it divides into the external and internal plantar nerves. It gives off:—

1. Muscular branches, to the deep muscles of the calf;
2. Plantar, cutaneous branch, supplies the skin on the inner side of the sole and heel;
3. Articular branch, to ankle-joint.

The internal plantar accompanies the corresponding artery to the inner side of the foot and gives off:—

1. Cutaneous branches;
2. Muscular branches;
3. Articular branches;
4. Four digital branches, supplying both sides of the first three toes and the inner side of the fourth.

The external plantar supplies by a superficial branch the outer side of the fourth and both sides of the fifth toes, and gives off a deep, or muscular branch.

The *external popliteal* or *peroneal* nerve descends to the inner side of the biceps tendon, pierces the peroneus longus about

1. External

2. Internal.

The mu

Internal
inner side of g
2. Exter
second, third,

one inch below the head, and divides into the anterior tibial and musculo-cutaneous. It gives off:—

1. Articular branches to knee-joint;
2. Cutaneous branches, one of which is the *communicans peronei*, which joins the short saphenous.

The *anterior tibial* accompanies the corresponding artery on its outer side to the ankle, where, after giving off an articular branch, it divides into:—

1. External or tarsal branch, to the tarsal and metatarsal joints, and
2. Internal, to the dorsal adjoining sides of the great and second toes.

The *musculo-cutaneus* gives off:—

Internal branches, supply skin of inner side of foot and ankle, and inner side of great toe;
2. External branch, to the dorsum of the adjacent sides of the second, third, fourth, and fifth toes.

Table of the Spinal Nerves.

- **First cervical nerve,**
  - Posterior division (suboccipital), → Complexus, recti, and obliqui muscles.
  - Anterior division (occipital), → Unites with the second cervical nerve, and supplies the anterior recti and rectus lateralis muscles.
- **Second cervical nerve,**
  - Posterior division,
    - External branch, → Splenius, complexus, trachelo-mastoid muscles.
    - Internal branch (great occipital), → With branch from third cervical, supplies the skin of the scalp.
  - Anterior division,
    - Small occipital,
    - Branch to great auricular,
    - Branch to superficial cervical,
    - Branch to communicans noni.
- **Third cervical nerve,**
  - Posterior division,
    - External and internal branches, → Splenius, semispinalis, complexus, trachelo-mastoid muscles.
  - Anterior division,
    - Branches to form the great auricular, superficial cervical, and communicantes minor.
- **Fourth to eighth cervical nerves,**
  - Posterior divisions,
    - External branches, → Muscles of the side of the neck.
    - Internal branches, → Skin and larger muscles of the neck.
  - Anterior division of fourth,
    - Branch to phrenic,
    - Branches to the trapezius, scalenus medius, levator anguli scapulæ muscles.
  - Anterior divisions, fifth to eighth, → Unite with the first dorsal nerve to form the brachial plexus.
- **Cervical plexus,**[1] Superficial branches,
  - Ascending,
    - Superficialis colli,
    - Auriculasis magnus,
    - Occipitalis minor.
  - Descending,
    - Supraclavicular.

[1] Formed by the anterior divisions of the first to the fourth cervical nerves.

TABLE OF THE SPINAL NERVES.—*(Continued.)*

- **Cervical plexus (*continued*), Deep branches,**
  - Internal set,
    - Muscular, Recti muscles.
    - Communicating,
    - Phrenic,
    - Communicans noni.
  - External set,
    - Muscular,
    - Communicating.
- **Brachial plexus,**[1] Above the clavicle,
  - Communicating, Tovphrenic.
  - Muscular, Scaleni., rhomboidei, longus colli, subclavius.
  - Posterior thoracic, Serratus magnus. (External respiratory nerve of Bell.)
  - Suprascapular, Shoulder-joint and supraspinatus muscle.
- **Brachial plexus,**[1] Below the clavicle,
  - Anterior thoracic,
    - External branch, Pectoralis major.
    - Internal branch, Pectoralis minor, Pectoralis major.
  - Three subscapular,
    - Upper, Subscapular muscle.
    - Lower, Teres major.
    - Middle, Latissimus dorsi.
  - Circumflex, Upper, Lower, Shoulder-joint, and muscles and skin about it.
  - Musculocutaneous,
    - Anterior branch, Integument of palmar surface of the wrist.
    - Posterior branch, Integument of dorsal surface of the wrist.

[1] Formed by the anterior branches of four lower cervical and first dorsal nerves.

TABLE OF THE SPINAL NERVES.—*(Continued.)*

Brachial plexus, below the clavicle, contin'd,

- Internal cutaneous, — Anterior and posterior branches, — Integument of inner side of the arm.
- Lesser internal cutaneous (Wrisberg's), — Integument of the inner side of the arm.
- Median,
  - Muscular, — Superficial anterior muscles, except flexor carpi ulnaris.
  - Anterior interosseous, — Deep anterior muscles, except the inner half of flexor profundus digitorum.
  - Palmar cutaneous, — Ball of thumb and palmar surface of the hand.
  - Branch to the muscles of the thumb, — Opponens, outer head of small flexor and abductor.
  - Digital branches, — Both sides of thumb, index and middle fingers, and radial side of ring finger.
- Ulnar, in forearm,
  - Articular, — (Elbow).
  - Muscular, — Inner half of deep flexors, and flexor carpi ulnaris.
  - Cutaneous, — Skin of the palm.
  - Dorsal cutaneous, — Both sides of little finger, and ulnar side of ring finger.
  - Articular, — (Wrist).
- Ulnar, in hand,
  - Superficial palmar, — Skin of both sides of little finger, and ulnar side of ring finger, and palmaris brevis muscle.
  - Deep palmar, — Interossei lumbricales, adductor pollicis, inner head of flexor brevis pollicis.

TABLE OF THE SPINAL NERVES.—*(Continued.)*

- **Brachial plexus, below the clavicle, cont'd,**
  - **Musculo-spiral,**
    - **Muscular branches,** — Supinator longus, extensor carpi radialis longior, triceps, anconeus, brachialis anticus.
    - **Radial,** — Supplies adjoining sides of thumb and index finger, index and middle, middle and ring fingers.
    - **Cutaneous,** — Inner side of arm, elbow, radial side of forearm, and wrist.
    - **Posterior interosseous,** — Posterior brachial and radial muscles, except those supplied by ulnar (muscular branches).
- **Dorsal nerves,**
  - **Posterior divisions,**
    - **External branches,**
    - **Internal branches,**

    — Muscles and skin of the back.
  - **Anterior divisions**[1]
    - **Upper six (thoracic intercostals),** — First intercostal crosses the axilla to join the lesser internal cutaneous (Wrisberg's).
      - **Lateral cutaneous,**
        - **Anterior,** — Skin of chest and mammæ.
        - **Posterior,** — Skin over scapula and lower dorsal region.
    - **Lower six (thoracico-abdominal intercostals),** — The last dorsal gives off the dorsi lumbar to the quadratus lumborum muscle.
- **Lumbar nerves,**
  - **Posterior divisions,**
    - **External branches,**
    - **Internal branches,**

    — Muscles of the skin of the back.
  - **Anterior divisions,** — The four upper unite to form the lumbar plexus. The fifth, with a branch from the fourth, joins the sacral nerves to form the lumbo-sacral cord.

[1] To the walls of chest and abdomen.

TABLE OF THE SPINAL NERVES.—*(Continued.)*

- **Lumbar plexus,**
  - **Ilio-hypogastric,**
    - **Iliac,** — Skin of gluteal region, oblique muscles of abdomen.
    - **Hypogastric,** — Skin of hypogastric region and oblique muscles.
  - **Ilio-inguinal,** — Skin of inner and upper part of thigh, scrotum, labium (in female).
  - **Genito-crural,**
    - **Genital,** — Cremaster muscle, round ligament (in female).
    - **Crural,** — Skin of front of thigh.
  - **External cutaneous,**
    - **Anterior,** — Skin of outer front aspect of thigh.
    - **Posterior,** — Skin of outer back aspect of thigh.
  - **Obturator,**
    - **Anterior,** — Femoral artery.
    - **Posterior,** — Adductor muscles.
    - **Articular,** — Synovial membrane of knee-joint.
  - **Accessory obturator,** — Branch to hip-joint, branch to anterior branch of obturator nerve.
  - **Anterior crural,**
    - **Anterior division,**
      - **Middle cutaneous,** — Sartorius muscle, skin of thigh (ant.).
      - **Internal cutaneous,** — Skin of inner aspect of leg.
      - **Long saphenous,** — Skin of inner side of foot.
    - **Posterior division,**
      - **Muscular,** — Muscles of the anterior and lateral aspect of thigh.
      - **Articular,** — Knee-joint.

TABLE OF THE SPINAL NERVES.—*(Continued.)*

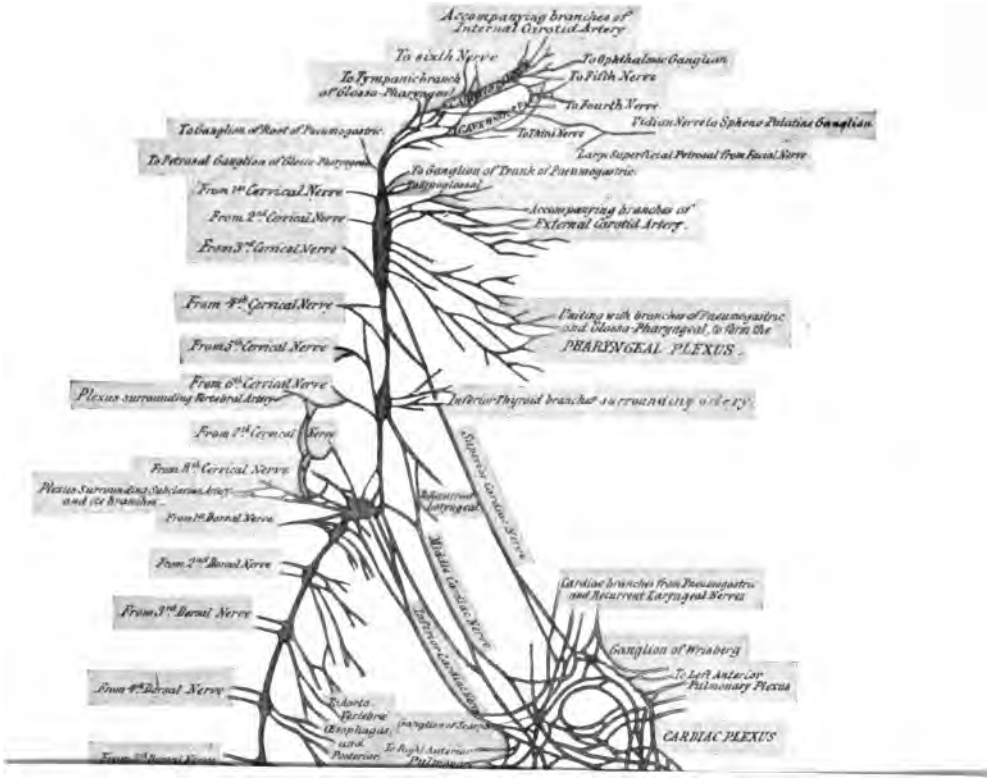
- **Sacral nerves,**
  - Posterior divisions, { External and internal branches, } Muscles and skin of the back.
  - Anterior divisions, { The four upper joining with the lumbo-sacral cord form the sacral plexus.

- **Sacral plexus,**
  - Muscular, { Obturators, gemelli, quadratus femoris, and pyriformis.
  - Superior gluteal, } Glutei muscles, and tensor vaginæ femoris.
  - Pudic,
    - Inferior hæmorrhoidal, } Skin of the anus.
    - Perineal, } Perineal structures.
    - Dorsal nerve of the penis, } Skin of the penis.
  - Articular, { To hip-joint.
  - Small sciatic,
    - Inferior gluteal, } Gluteus maximus.
    - Internal cutaneous,
      - Branch to skin of inner and upper part of thigh.
      - Inferior pudendal, skin of scrotum, labium in female.
    - Ascending cutaneous, } Skin over gluteus maximus.
  - Great sciatic,
    - Articular, { Hip-joint.
    - Muscular, { Muscles of inner and posterior part of thigh.
    - Bifurcation, { External, Internal, } Popliteal.

- **Internal popliteal,**
  - Articular branches, } To knee-joint.
  - Muscular branches, } To muscles of the posterior aspect of the leg.

TABLE OF THE SPINAL NERVES.—*(Continued.)*

- **Internal popliteal (*continued*),**
  - Communicans poplitei, → Skin of outer side of the foot.
  - Posterior tibial (continuation),
    - Muscular, → Deep muscles of the calf.
    - Plantar cutaneous, → Skin of inner side of sole and heel.
    - Articular, → To ankle-joint.
    - Bifurcation,
      - Internal plantar,
      - External plantar.
    - Internal plantar,
      - Cutaneous,
      - Muscular,
      - Articular,
      - Four digital.
    - External plantar, → Supplies the outer side of the fourth and both sides of the fifth toes. Muscular branch.
- **External popliteal (peroneal),**
  - Articular, → To knee-joint.
  - Two cutaneous, → Communicans peronei.
  - Anterior tibial,
    - External or tarsal branch, → Tarsal and metatarsal joints.
    - Internal branch, → Inner and dorsal, adjoining sides of great and second toes.
  - Musculo-cutaneous,
    - Internal branches, → To skin of inner side of foot and ankle.
    - External branch, → To dorsum of adjacent sides of third, fourth, and fifth toes.


Accompanying branches of Internal Carotid Artery
To sixth Nerve
To Ophthalmic Ganglion
To Tympanic branch of Glosso-Pharyngeal
To Fifth Nerve
To Fourth Nerve
To third Nerve
Vidian Nerve to Sphenopalatine Ganglion
To Ganglion of Root of Pneumogastric
Large Superficial Petrosal from Facial Nerve
To Petrosal Ganglion of Glosso-Pharyngeal
To Ganglion of Trunk of Pneumogastric
From 1st Cervical Nerve
From 2nd Cervical Nerve
Accompanying branches of External Carotid Artery
From 3rd Cervical Nerve
From 4th Cervical Nerve
Uniting with branches of Pneumogastric and Glosso-Pharyngeal, to form the PHARYNGEAL PLEXUS
From 5th Cervical Nerve
From 6th Cervical Nerve
Plexus surrounding Vertebral Artery
Inferior Thyroid branches surrounding artery
From 7th Cervical Nerve
From 8th Cervical Nerve
Plexus surrounding Subclavian Artery and its branches
From 1st Dorsal Nerve
From 2nd Dorsal Nerve
From 3rd Dorsal Nerve
From 4th Dorsal Nerve
Cardiac branches from Pneumogastric and Recurrent Laryngeal Nerves
Ganglion of Wrisberg
To Left Anterior Pulmonary Plexus
CARDIAC PLEXUS

THE SYMPATHETIC NERVOUS SYSTEM.

The sympathetic system, like the cerebro-spinal axis, is double, consisting of a *gangliated cord* on each side, extending the entire length of the vertebral column, and numerous nerve-fibres, both *communicating,* by which it anastomoses with the cerebro-spinal axis, and *distributory,* by which the blood-vessels and viscera are supplied.

Branches of the ganglionated cords ascend through the carotid canal to communicate with the ganglia of the fifth cranial nerve, and also with each other through the *ganglion of Ribes,* situated upon the anterior communicating artery. They also communicate below in the *ganglion impar,* located in front of the coccyx.

The ganglia of each cord correspond very nearly in position and number to the vertebræ, except in the cervical region, where there are but three: cervical three, dorsal twelve, lumbar four, sacral five.

From the ganglionated cords three important plexuses are given off—the cardiac, solar, and hypogastric—situated in the thoracic, abdominal, and pelvic cavities respectively.

Cranial Ganglia—Ganglia Connected with the Fifth Cranial Nerve.—Besides the Gasserian ganglion upon the root there are four—ophthalmic, spheno-palatine, otic, and submaxillary—each of which have three branches of communication or *roots*—motor, sensory, and sympathetic—besides several branches of distribution.

The *ophthalmic,* or *ciliary,* ganglion is situated in the orbit between the external rectus muscle and optic nerve upon the first division of the fifth cranial nerve.

Its sensory root is from the nasal branch of ophthalmic, motor root from the motor oculi or third and sympathetic from the cavernous plexus.

Its branches are the short ciliary nerves (*vide* Eye).

Spheno-palatine, or *Meckel's,* the largest, is situated in the spheno-maxillary fossa upon the superior maxillary, or second division of the fifth.

Its sensory root is derived from the superior maxillary, its motor root, from the facial, through means of the Vidian, and its sympathetic from the carotid plexus. Its branches are:—

1. Ascending;
2. Descending, or palatine, { Anterior, or large palatine, Middle, or external palatine, Posterior, or small palatine;

3. Internal,	{ Superior nasal, { Naso-palatine;
4. Posterior,	{ Vidian, Large superficial petrosal, Deep petrosal, Pharyngeal branch.

The *Vidian nerve* passes from the back part of Meckel's ganglion through the foramen lacerum medium, where it divides into the large superficial and deep petrosal nerves. It gives off the upper posterior nasal branches to the mucous membrane of septum, orifice of Eustachian tube, and roof of the nose. Or, more correctly, the Vidian is formed by the union of the great petrosal (large superficial petrosal) from the facial and the large deep petrosal from the carotid sympathetic, runs forward through the Vidian canal, and joins the spheno-palatine ganglion (Meckel's). In this description, the nerves given off to the nasal mucous membrane must be considered branches from the ganglion inclosed in the same sheath.

The *large superficial petrosal branch* enters the cranium through the foramen lacerum medium, passes beneath the dura mater and Gasserian ganglion, enters the hiatus Fallopii, receives a branch from the tympanic branch of the glosso-pharyngeal (Jacobson's), and through the aquæductus Fallopii to terminate in the geniculate ganglion of the facial nerve.

The *large deep petrosal branch* crosses the foramen lacerum medium to the carotid canal, where it joins the carotid plexus of the sympathetic.

The *pharyngeal* or *pterygo-palatine* nerve desends from the back part of the ganglion through the pterygo-palatine canal, to supply the upper part of the pharynx.

Besides the Vidian and its branches there are two other petrosal nerves (*vide* Facial Nerve), the small and external petrosal.

The *small petrosal* connects the geniculate ganglion of the facial, within the aquæductus Fallopii, with the otic ganglion.

The *external petrosal* connects the geniculate ganglion of the facial, within the same canal, with the sympathetic plexus of the middle meningeal plexus.

The *otic ganglion* (Arnold's) is placed below the foramen ovale upon the inferior maxillary nerve, or third division of the fifth.

Its sensory root is derived from the auriculo-temporal branch of the inferior maxillary; the motor root, from the internal pterygoid branch of the same, the sympathetic root, from the plexus on the middle meningeal artery. Branches are distributed to the tensor palati and tensor tympani muscles.

The *submaxillary ganglion* is placed above the deep portion of the submaxillary gland.

Its sensory root is derived from lingual branch of inferior maxillary; its motor root, from the facial nerve through a branch of the chorda tympani; and its sympathetic, from the plexus of the facial artery.

Beside these ganglia, situated upon branches of the trifacial nerve, the following are found within the cavity of the cranium:—

Ganglion of Ribes, on the anterior communicating artery;
Ganglion of Bidder, on the middle meningeal artery;
Ganglion of Laumonier, on the internal carotid artery;
Ganglion of Cloquet, on the naso-palatine nerve in the incisor fossa;
Ganglion of Bochdaleck, near the spheno-palatine ganglion.

Cervical Ganglia.—The cervical ganglia consist of three,—superior, middle, inferior,—of which the superior is the largest and the middle the smallest. These are connected above with the cranial ganglia, below with the thoracic ganglia, and communicate with each other.

The *superior cervical ganglion* lies opposite the second or third cervical vertebra, behind the internal carotid artery. It is connected with the middle ganglion, the upper four cervical, and tenth and twelfth cranial nerves, distributes branches to the carotid (internal), cavernous, and pharyngeal plexuses, and gives off the *superior cardiac nerve* to the cardiac plexus.

The *middle cervical ganglion* lies upon inferior thyroid artery, opposite fifth cervical vertebra. It is connected with the upper and lower ganglia and spinal nerves, and gives off the *middle cardiac nerve* to cardiac plexus.

The *inferior cervical ganglion* lies internal to the superior intercostal artery, below the last cervical vertebra. It is connected to the middle ganglion, first thoracic, lower cervical nerves, forms the vertebral plexus, and gives off the *inferior cardiac nerve* to cardiac plexus.

Thoracic ganglia lie upon the heads of the ribs on each side of the vertebral column. They are connected with the inferior cervical ganglion above, the lumbar ganglion below, the dorsal spinal nerves behind, and give off internal branches divided into two sets of six each—upper and lower.

Internal branches from upper set are distributed to the pulmonary and aortic plexuses, and internal branches from lower set unite to form the three splanchnic nerves,—great splanchnic, lesser splanchnic, renal splanchnic,—distributed respectively to the semilunar ganglion, renal and suprarenal plexuses, and to renal and cœliac plexuses.

The *lumbar ganglia* lie along inner margin of the psoas muscle. They communicate above and below with the other ganglia and with the lumbar spinal nerves, and give off internal branches which form the hypogastric plexus.

The *sacral ganglia* are situated internal to the anterior sacral foramina. They unite below in front of the coccyx in the coccygeal ganglion, or *ganglion impar.* They communicate with the sacral nerves, join the pelvic plexus, and send branches on the middle sacral artery.

CARDIAC PLEXUS.—The cardiac plexus, formed from the superior, middle, and inferior cardiac nerves from the cervical ganglia, and the cardiac branches from the pneumogastric and recurrent laryngeal, consists of two portions—the superficial and deep.

The *superficial cardiac plexus,* situated beneath the arch of the aorta, is formed by the left superior cardiac nerve and the left inferior cervical cardiac nerve, and contains the *cardiac ganglion* of Wrisberg. It forms part of the anterior coronary plexus, and sends branches to the left anterior pulmonary plexus.

The *deep cardiac plexus* lies between the arch of the aorta and trachea, and receives all the cardiac nerves except the two mentioned above. It forms part of the anterior coronary and posterior coronary plexuses.

The SOLAR PLEXUS, or "abdominal brain," consists of ganglia and a net-work of nerve branches, formed chiefly from the branches of the two great splanchnic nerves and branches from the right pneumogastric. It is situated between the aorta and the crura of the diaphragm and the stomach, and surrounds the superior mesenteric artery and cœliac axis.

Its ganglia are two crescentic ganglionic masses—the *semilunar* ganglia (the largest in the body)—situated in front of the crura of the diaphragm. They are composed of smaller ganglia aggregated together. From the solar plexus and semilunar ganglion are derived numerous branches which are distributed as plexuses over all the abdominal arteries, as follows:—

Cœliac,	Phrenic,	Aortic,
Gastric,	Suprarenal,	Superior mesenteric,
Hepatic,	Renal,	Inferior mesenteric,
Splenic,	Spermatic,	Ovarian.

The HYPOGASTRIC PLEXUS is situated below the bifurcation of the aorta, in front of the sacrum, and is formed by branches from the lumbar ganglia and aortic plexus. It divides into two parts which, with branches from the sacral ganglia and nerves, become the pelvic plexuses.

THE INFERIOR HYPOGASTRIC OR PELVIC PLEXUS on each side gives off the following branches:—

Vesical plexus,		Inferior hæmorrhoidal,
Prostatic plexus,	Small cavernous nerves,	to penis,
	Large cavernous nerves,	
Vaginal plexus,		Uterine plexus.

ORGANS OF SPECIAL SENSE.

THE NOSE.

THE nose, the special organ of smell, consists of two parts,—the external prominence, or nose proper, and the internal cavities, or nasal fossæ.

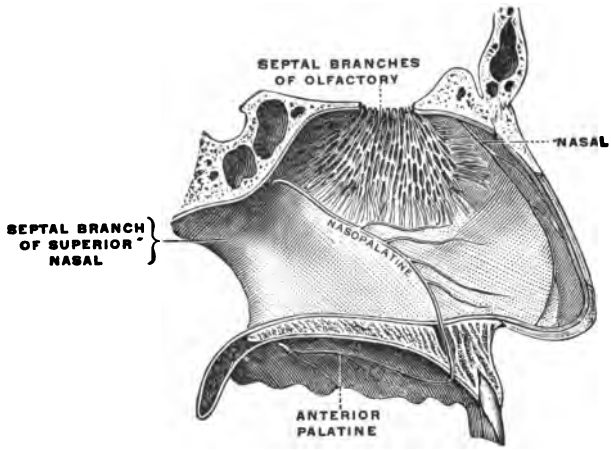


FIG. 152.

The olfactory nerves and nerves of common sensation to the nose. (*Eckley.*)

The *nose proper* is made up of a cartilago-osseous frame work covered with muscles (*vide* Muscles) and skin, and lined with mucous membrane. The osseous portion is formed by the margins of the anterior meatus (*vide* Osteology).

The cartilaginous portion consists of an upper and lower lateral cartilage on either side, and the nasal septum dividing the nasal cavity into two nasal fossæ.

Arteries are from nasal branch of ophthalmic and infra-orbital, nasal artery from superior coronary, and branches of the lateralis nasi.

Veins empty into the ophthalmic and facial veins.

Nerves from infratrochlear, infraorbital, and facial.

FIG. 153.

Nasal meatuses and accessory cavities. 1, right termination of the left frontal sinus; 2, right frontal sinus; 3, probe extending from the right frontal sinus through the infundibulum into the right nasal fossa; 4, ethmoid cells; 5, large opening into the maxillary sinus; 6, anterior antrum of the sphenoid bone; 7, posterior sphenoid antrum; 8, middle nasal meatus; 9, inferior meatus; 10, inferior turbinated bone; 11, probe extending through the nasal duct. (*Bishop.*)

The *nasal fossæ* are the two bony cavities already described (*vide* page 36). They are lined throughout with mucous membrane called *Schneiderian membrane,* which is continuous with the antrum of Highmore, frontal, ethmoidal, and sphenoidal sinuses, with the conjunctiva through the lachrymo-nasal duct, with the pharynx through the posterior nares, and with cavity of the tympanum through the Eustachian tube. Its epithelium is columnar, ciliated in the lower part and the sinuses, and is

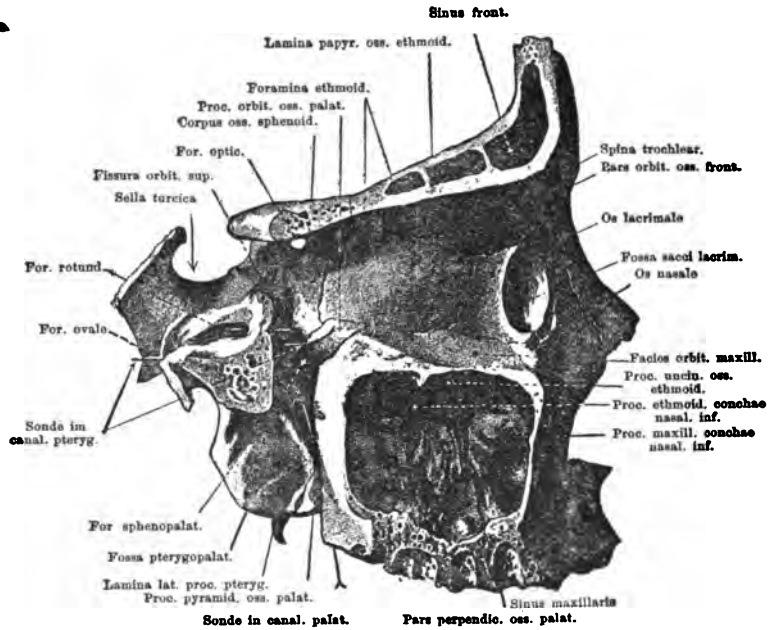


FIG. 154.

Inner wall of orbit and adjacent parts. (*His.*) (*Ball.*)

columnar but not ciliated in the membrane to which the olfactory nerve is distributed.

Arteries are anterior and posterior ethmoidal from the ophthalmic to the roof, frontal and ethmoidal sinuses, sphenopalatine from the internal maxillary to the mucous membrane of the spongy bones, septum, and meatuses, and alveolar from the internal maxillary to the antrum.

Veins empty into facial, ophthalmic, and beginning of great longitudinal sinus.

Nerves are:—

Olfactory, or first cranial, the special nerve of smell, is distributed over the upper third of the septum, and superior turbinated bones.

Anterior dental branch of superior maxillary to the inferior turbinated bone and inferior meatus.

Nasal branch of ophthalmic, to the outer walls and septum. Besides these, the spheno-palatine ganglion, the vidian, the superior nasal branch, naso-palatine, and anterior palatine also send branches to the parts.

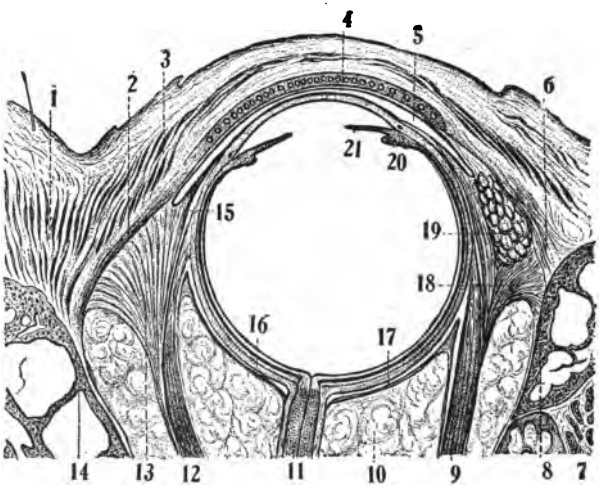


FIG. 155.

Horizontal section of right orbit. 1, Horner's muscle; 2, septum orbitale; 3, fibres of the orbicularis palpebrarum muscle; 4, tarsal plate; 5, conjunctival sac; 6, outer palpebral ligament; 7, temporal muscle; 8, wall of the orbit; 9, external rectus muscle; 10, orbital fat; 11, optic nerve; 12, internal rectus muscle; 13, inner check ligament; 14, inner wall of the orbit; 15, attachment of the capsule of Tenon (16) to the conjunctiva; 17, Tenon's space; 18, outer check ligament; 19, lachrymal gland; 20, ciliary process; 21, iris. (*After Gerlach.*) (*Ball.*)

THE EYE.

THE ORGANS OF SIGHT comprise the eyeballs and their appendages and the optic nerves.

The eye is a spherical organ, situated in the anterior part of the skull, protected in front by several appendages, acted upon by muscles, and supplied by blood-vessels and nerves.

Within the orbit it rests upon a bed of fat, from which it is separated by a membranous sac—the capsule of Tenon.

It presents the following:—

Diameters.—Antero-posterior, in the adult, .950 inch; transverse, .925; vertical, .915; oblique, .943.

Anterior and *posterior poles* are the geometric centres of the cornea and fundus respectively.

Optic axis is a straight line passing through the cornea and posterior pole of the eye.

Line of vision, or visual axis, is an imaginary line which connects the point of fixation with the fovea centralis, through the nodal point, usually to the outer side of the centre of the pupil. It forms with the optic axis as it cuts the cornea, the *visual angle*—an angle of from 3° to 7°.

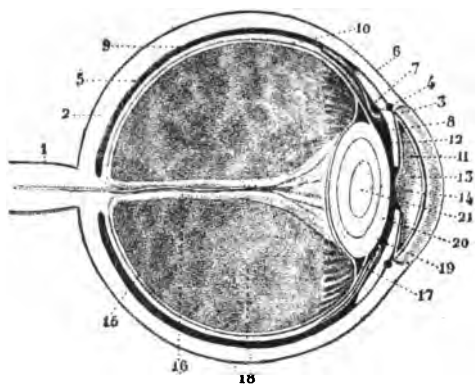


FIG. 156.

Antero-posterior section of Eyeball. 1, optic nerve; 2, sclera; 3, cornea; 4, spaces of Fontana; 5, choroid; 6, ciliary muscle; 7, ciliary processes; 8, iris; 9, retina; 10, Jacob's membrane; 11, anterior chamber; 12, posterior chamber; 13, pupillary area; 14, aqueous humor; 15, hyaloid membrane; 16, canal of Stilling; 17, canal of Petit; 18, vitreous humor; 19, capsule of the lens; 20, fluid of Morgagni; 21, lens. (*Léveillé.*) (*Ball.*)

Nodal point is an imaginary point—the centre of curvature of the refracting media—where all the luminous rays pass without deviation.

Equatorial plane, an imaginary plane passing through the centre of the eyeball at right angles to the optic axis, dividing the globe into two hemispheres—the anterior and posterior.

Equator is the line upon the surface of the globe where the equatorial plane cuts it.

Meridional planes are imaginary antero-posterior planes coinciding with the axis.

Meridians are the lines upon the surface where these meridional planes cut it.

THE CAPSULE OF TENON, tunica vaginalis oculi, is a fascia between the eyeball and the walls of the orbit, isolating the eyeball and allowing free movement. It is continuous in front with the subconjunctival connective tissue, and behind with the dura mater, through the sphenoidal fissure and optic foramen, and consists of two layers—a visceral layer investing the posterior portion of the eyeball, and a parietal layer lining the cushion of fat on which the eye rests.

The inner aspect is lined with flattened endothelial cells, and incloses a lymph space communicating with *subdural* and *subarachnoidean* lymph spaces of the optic nerve-sheath. It supports the lachrymal gland, is strengthened by numerous fibrous bands, and is pierced by the ocular muscles, inclosing them in imperfect sheaths.

The *capsule of Bonnet* is the name given to the portion posterior to the passage of the tendons, and

The *capsule of Tenon* is then applied to the anterior socket-like half.

THE EYEBALL is composed of a large, opaque segment of a sphere, forming about five-sixths of the globe, for the protection of its contents, and a smaller transparent segment of a sphere, implanted upon and continuous with it in front. The optic nerves enter the eyeballs to their nasal side, in the direction of the axes of the orbit.

It is composed of three tunics or coats:—

1. Sclerotic and cornea,
2. Choroid, iris, and ciliary processes,
3. Retina;

And three humors, or refracting media:—

1. Aqueous humor,
2. Crystalline lens (and capsule),
3. Vitreous humor, or body.

THE SCLEROTIC COAT, so called from its extreme hardness, is thicker behind (one twenty-fifth of an inch) than in front (one-sixtieth of an inch), and presents two surfaces for study—the external and internal.

The *external surface* is smooth and white, and has attached to it the various muscles of the eye.

The *internal surface* is grooved for the passage of the ciliary nerves, and connected to the choroid by a fine areolar layer—the *lamina fusca.*

Behind, and a little to the nasal side, where the optic nerve enters, it presents a perforated appearance—the *lamina cribrosa*—the larger opening of which—the porus opticus—transmits the arteria centralis retinæ; the others transmit the ciliary vessels and nerves. It is continuous in front with the cornea, overlapping it a little on its outer margin.

In *structure* it is made up of white, fibrous tissue, with a small quantity of elastic fibres, and connective-tissue corpuscles. It probably contains no nerves.

THE CORNEA is the convex, transparent, nearly circular tissue forming the anterior one-sixth of the globe. It is from one twenty-second to one thirty-second of an inch in thickness. Its thickness at the periphery is 1.12 millimetres, hence its posterior surface is more curved than the anterior. Its transverse diameter is a little greater than the vertical, owing to the overlapping of the sclerotic above and below. It is composed of four layers:—

1. Conjunctival epithelium;
2. Cornea proper, { Anterior elastic lamina, Cornea proper;
3. Posterior elastic lamina, } Membrane of Descemet.
4. Epithelial lining, }

The *conjunctival epithelium* consists of several layers of cells (columnar, polyhedral, and squamous) covering the anterior surface of the cornea, continuous with the conjunctiva.

The *anterior elastic lamina* is the name given to the outer epithelial layer of the cornea proper.

The *cornea proper* is made up of a transparent fibrous structure, identical with the sclerotic, and consisting of about sixty layers or lamina, connected by a cement substance inclosing *corneal spaces,* each of which contains a *corneal corpuscle.*

The *posterior elastic lamina* consists of an elastic homogeneous membrane, internal to the proper structure of the cornea, and constituting, with the epithelial lining, the *membrane of Descemet,* or *Demours.*

The *structure* of the cornea is non-vascular, being nourished by channels representing lymphatic vessels, and continuous with the corneal spaces. The nerves derived from the ciliary nerves are numerous, and form between the outer surface of the cornea proper and the epithelial covering the *subepithelial plexus,* from which is given off the *intraepithelial* plexus.

The second tunic consists of the choroid, lining the sclerotic coat throughout; the iris, the circular curtain suspended in the

aqueous humor and perforated by the pupil; and the ciliary ligament and muscle at the junction of the two.

THE CHOROID is a dark, reddish-brown, highly vascular membrane, lining the sclerotic coat from the optic nerve to the ciliary ligament, where it projects backward in a number of processes, the *ciliary processes.* It is in contact externally with the sclerotic, to which it is attached by the membrana fusca, and internally with the retina.

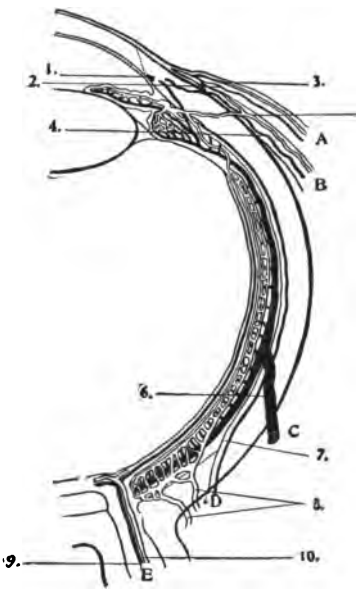


FIG. 157.

Vessels of the eye. A, conjunctival vessels; B, anterior ciliary vessels; C, vena vorticosa; D, posterior ciliary arteries; E, central retinal vessels. (*Ball.*)

The *structure* consists chiefly of a dense capillary net-work.

The *choroid proper* consists of an external and an internal layer, and is separated from the sclerotic by the *lamina supra choroidea,* continuous with the lamina fusca of the sclerotic, and from the pigmentary layer of the retina by the *lamina vitrea.*

The *external layer* consists of a capillary net-work, derived from the larger branches of the short ciliary arteries, inclosing between the meshes large, star-shaped pigment cells, which are connected together by a delicate stroma. They terminate in the

venæ verticosæ, which emerge through the sclerotic midway between the optic nerve and the margin of the cornea.

The *internal* layer is also composed of a fine capillary network, derived from the short ciliary arteries, and continuous in front with the vessels of the ciliary processes. It is called the *tunica Ruyschiana.*

The *vitreous membrane lamina vitrea* is a thin, structureless layer, separating the pigmentary layer of the retina from the membrana Ruyschiana.

The *arteries* are from posterior ciliary, short ciliary (principally in the external layer), and recurrent branches of long and anterior ciliary.

The *veins* converge from the venæ verticosæ to form four or five trunks, which pierce the sclerotic midway between the optic nerve and corneal margin to join the cavernous sinus.

The *nerves* are the long and short ciliary.

The *ciliary processes* are a series of sixty to eighty pigmented vascular processes arranged circularly around the lens behind the iris, and composed of the two internal layers of the choroid folded inward. They are continuous in front with the iris, and are connected behind with the suspensory ligament of the lens.

The *structure* is similar to that of the choroid.

THE IRIS is a thin, circular curtain, suspended in the aqueous humor, between the lens and cornea, and perforated by a circular aperture—the *pupil.*

Its circumference is connected with the choroid, and also by means of the ciliary ligament with the sclerotic and cornea. The sclerotic contains in this position, near its junction with the cornea, a circular canal (lymph canal, or venous sinus), the *sinus circularis iridis,* or *canal of Schlemm.*

The circumference of the iris is also connected in front with the cornea by *ligamentum pectinatum iridis,* derived from the membrane of Descemet.

The *structure* is composed of four elements:—

1. A basement membrane and polyhedral cells, continuous with the membrane of Descemet;

2. Stroma, consisting of bundles of fibrous tissue and cells;

3. Muscular fibres, { Circular fibres, forming the sphincter of the pupil; Radiating fibres, forming the dilator of the pupil;

4. *Pigment,* consisting of polyhedral or round pigment cells, distributed for the most part to the posterior surface, which, from its deep-purple tint, has been called the uvea.

The *arteries* are from the long and anterior ciliary and from the ciliary processes (from the short ciliary).

The *veins* join those of the ciliary processes and anterior ciliary veins.

The *nerves* are the long ciliary from the nasal branch of the ophthalmic (first division of fifth), and ciliary branches from the lenticular or ophthalmic ganglion.

The circular fibres are supplied by the fibres from the third or motor oculi, the radiating fibres are supplied by the sympathetic.

The *membrana pupillaris* is a delicate, vascular membrane, closing the pupil in the fœtus, continuous at its margin with the iris. It usually disappears about the eighth month, but occasionally persists.

The *ciliary muscle* is a grayish, circular band of unstriated fibres, attached to the fore part of the choroid. It consists of two sets of fibres—the external radiating fibres, *dilator pupillæ*—arising from the junction of the sclerotica and cornea, and is inserted into the choroid opposite the ciliary processes; the internal circular fibres, *sphincter pupillæ,* pursue a circular course around the insertion of the iris.

It is the muscle of accommodation, its contraction drawing on the ciliary processes, relaxing the circular fibres described as the ligament of the lens, and allowing the anterior surface of the lens to become more convex by its inherent elasticity.

THE RETINA is a delicate, white, nervous membrane, the expansion of the optic nerve. It lines the eyeball, being in contact externally with the choroid and internally with the vitreous body. It terminates in front near the ciliary ligament in an irregular margin, the *ora serrata,* but is prolonged forward as the *pars ciliaris* to the iris. Its internal posterior surface presents at a point corresponding to the axis of the eyeball a small, round, elevated spot of yellowish color, the *macula lutea,* or *yellow spot* of Sömmering, in the centre of which is the *fovea centralis,* a central depression, the region of most acute vision, and about one-tenth of an inch to its nasal side, at a point corresponding to the axis of the orbit, the entrance of the optic nerve, an oval, bluish-white depression, with distinct, often pigmented margins, a region destitute of vision and called the *optic disk.* Its centre presents the arteria centralis retinæ, giving branches to the nasal upper and lower side of the macular region.

The *structure* of the retina is exceedingly complex, consisting microscopically of ten distinct layers from within outward, as follows:—

1. *Membrana limitans interna*, the most internal layer of the retina, forms the base of the connective-tissue frame-work of the retina, from which it is derived.

2. The *fibrous layer* consists of nerve-fibres, the termination of the optic nerve-fibres.

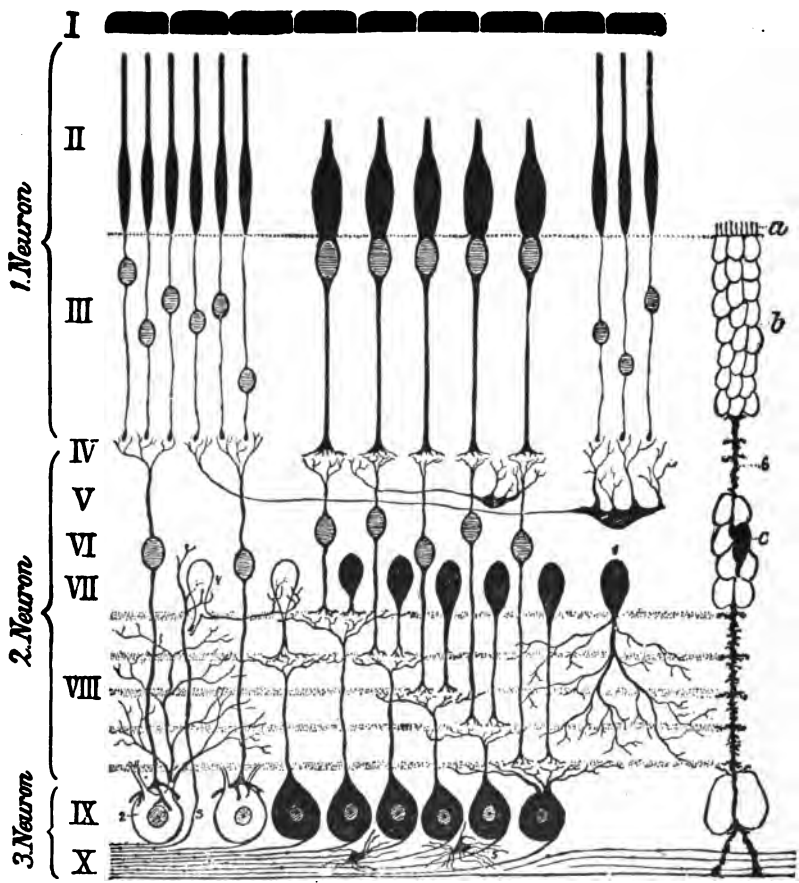


FIG. 158.

The structure of the human retina. I, pigment epithelium layer; II, rods and cones; III, granules of the visual cells; IV, outer plexiform layer; V, layer of horizontal cells; VI, layer of bipolar cells; VII, layer of amakrine cells; VIII, inner plexiform layer; IX, ganglion-cell layer; X, layer of nerve-fibres; 1, diffuse amakrine cell; 2, diffuse ganglion cell; 3, centrifugal nerve-fibre; 4, amakrine association fibres; 5, neuroglia-cells; 6, Müller's radial fibres. (*After Greeff.*) (*Ball.*)

3. The *vesicular layer*, composed of a layer of large, flask-shaped ganglionic cells. It is wanting in the muscular region.

4. The *inner molecular layer* is composed of a layer of glandular-like structure, forming a reticulum inclosing minute granules.

5. The *inner nuclear layer* is composed of three sets of nuclear bodies, the first resembling bipolar nerve-cells, the second without branches, and the third continuous with the radiating fibres, or fibres of Müller.

6. The *outer molecular layer* resembles closely the inner molecular layer, from which it differs only by containing branched stellate cells.

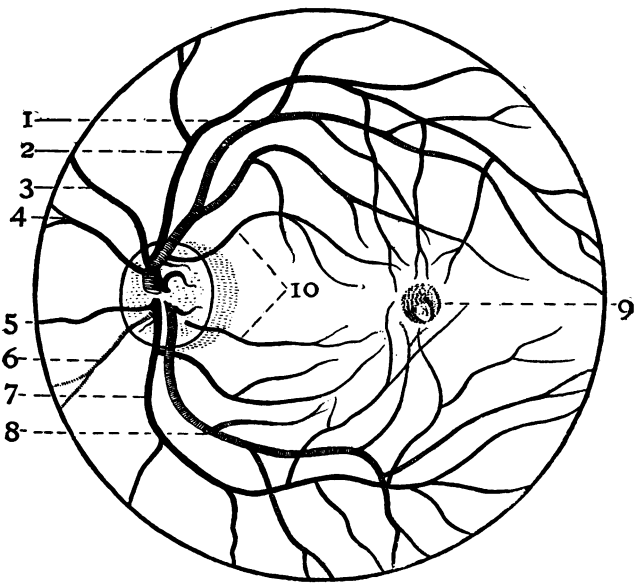


FIG. 159.

Diagram of the retinal vessels. 1, superior temporal artery; 2, superior temporal vein; 3, superior nasal vein; 4, superior nasal artery; 5, inferior nasal vein; 6, inferior nasal artery; 7, inferior temporal vein; 8, inferior temporal artery; 9, macula lutea; 10, macular veins. (*Ball.*)

7. The *outer nuclear layer* is composed of several layers of nuclear cells, separable into two kinds, the *rod granules* and *cone granules*, both continuous with the rods and cones of Jacob's membrane.

8. The *membrana limitans externa* is, like the internal limiting membrane, derived from the radiating fibres, or fibres of Müller.

9. *Jacob's membrane*, or the layer of rods and cones, consists of two distinct kinds of cells—the rods and cones, distributed alternately throughout this layer, the rods being much more numerous.

The rods are solid, stand perpendicularly to the surface, and consist of two portions—an outer striated and an inner granular.

The cones are flask-shaped, with their pointed extremities toward the choroid. They also consist of two portions—an outer striated and an inner granular.

10. The *pigmentary layer* was formerly described as a layer of the choroid. It has received the name of *tapetum nigrum*, consisting of a layer of pigmented hexagonal epithelial cells.

In many of the lower animals, this layer on the posterior surface is destitute of pigment, and is called from its iridescent lustre the *tapetum lucidum*.

The *radiating fibres*, or *fibres of Müller*, consist of connective-tissue fibres, connecting all the layers together, and forming the membrana limitans interna and the membrana limitans externa.

The *structure* of the retina at the *macula lutea* differs in the following manner: the cones only of Jacob's membrane are present; the vesicular layer consists of several layers, and in the outer nuclear layer only the cone-fibres are present.

At the fovea centralis only the cones of Jacob's membrane, the outer nuclear layer, and the internal granular layer are present.

The *arteria centralis retina* supplies only as far as the inner nuclear layer.

THE HUMORS OF THE EYE.

THE AQUEOUS HUMOR is a transparent, alkaline, serous fluid, small in quantity, weighing four to five grains, and filling the anterior and posterior chambers of the eye. It is composed of water, 96.7; extractive matters, principally chloride of sodium and albumen, 0.1.

The *anterior chamber* is the space (about 2.7 millimetres in depth) between the iris and the cornea.

The *posterior chamber* is the space between the anterior surface of the lens and the iris. It amounts to a space only at the circumference, the two being in contact at the posterior surface.

THE CRYSTALLINE LENS is a biconvex, transparent, elastic body, suspended within its capsule, surrounded by the ciliary processes. It is more convex on its posterior surface (anterior surface has an average radius of ten millimetres, the posterior six millimetres), and is received into a hollow depression in the hyaloid membrane.

It measures about one-third inch in diameter, one-fourth inch in axis, and weighs from four to four and one-half grains.

Its index of refraction increases from the periphery to the centre, with an average of 1.4371.

Its composition consists of about 60 per cent. water; soluble albuminous matter, 35 per cent.; insoluble albuminous matter, 2.5 per cent.; cholesterine and fat, 2 per cent.

The *structure of the lens* consists of concentric laminæ, made up of hexagonal prisms, about one five-thousandth inch in breadth, united laterally by dentated margins, and curving round the borders of the lens. The laminæ are arranged into three triangular segments.

The central portion, or *nucleus,* is unstratified, while the outer layers, or *cortex,* each contain a nucleus, forming a nuclear layer.

The *capsule of the lens* is a clear, elastic, brittle membrane, inclosing the lens, and held in position by the suspensory ligament. Its anterior layer is thicker, and is attached to the lens by a layer of polygonal nucleated cells, which break down post-mortem to form the *liquor Morgagni.*

The *canal of Petit* is about one-tenth of an inch in diameter, encircling the capsule of lens. Its base is formed by the capsule, and it is bounded in front by suspensory ligament, behind by the hyaloid membrane of the vitreous humor.

The *suspensory ligament,* or zonula of Zinn, is a thin, transparent structure, extending from the margins of the hyaloid fossa, where it is continuous with hyaloid membrane, to the anterior margin of the lens.

THE VITREOUS HUMOR, or BODY, is a clear, albuminous fluid, filling the cavity of the retina, hollowed out in front—*hyaloid fossa*—for the lens, and inclosed in the *hyaloid membrane.* It is composed of water, with a few salts, and a little albumen.

Its structure is finely reticular, particularly in the fœtus.

The *canal of Stilling, canal of Cloquet,* or *hyaloid canal,* is a canal extending in the fœtus from the entrance of the optic nerve to the lens, containing fluid, and lined by a fold of hyaloid membrane.

In the fœtus a canal extends parallel but independent of this, and transmits a minute artery to the capsule of the lens.

The *hyaloid membrane* is a delicate capsular membrane, investing the vitreous body, excepting its anterior surface, sends fibrous septa into the structure of the vitreous, and is continuous in front with the posterior capsule, and with the anterior capsule through the suspensory ligament.

MUSCLES OF THE EYEBALL.

RECTUS SUPERIOR.—*Origin,* sheath of the optic nerve and upper margin of optic foramen; *insertion,* into upper surface of sclerotic coat, three or four lines from corneal margin; *action,* rotates the eyeball upward; *nerve,* third cranial.

RECTUS INFERIOR.—*Origin,* from lower and inferior part of optic foramen (ligament of Zinn); *insertion,* into lower surface of sclerotic; *action,* rotates the eyeball downward; *nerve,* third cranial.

RECTUS INTERNUS.—*Origin,* same as inferior rectus; *insertion,* into inner surface of sclerotic; *action,* rotates the eyeball inward; *nerve,* third cranial.

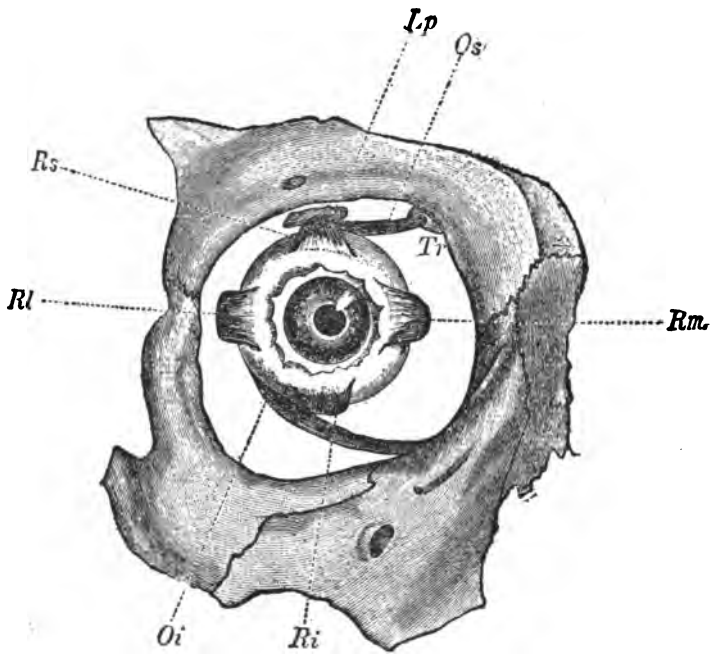


FIG. 160.

The orbital muscles. Lp., levator palpebræ superioris; Os, superior oblique; Rs, superior rectus; Rl, external rectus; Oi, inferior oblique; Ri, inferior rectus; Rm, internal rectus; Tr, trochlea. (*Ball.*)

RECTUS EXTERNUS.—*Origin,* by two heads—lower, from ligament of Zinn and lower margin of sphenoidal fissure; upper, from outer margin of optic foramen; *insertion,* into outer surface of sclerotic; *nerve,* abducens, or sixth cranial. Passing between the two heads are the ophthalmic vein, the third, nasal branch of fifth, and sixth nerves.

SUPERIOR OBLIQUE.—*Origin,* from inner margin of optic foramen. Its tendon passes through a pulley near the internal angular process of the frontal bone; *insertion,* into sclerotic between external and superior recti, midway between entrance of optic nerve and the cornea; *action,* rotates the eyeball on its axis; *nerve,* fourth, or patheticus.

INFERIOR OBLIQUE.—*Origin,* orbital plate of superior maxilla; *insertion,* near that of superior oblique, between external and superior recti; *action,* rotates the eyeball on its axis; *nerve,* third cranial.

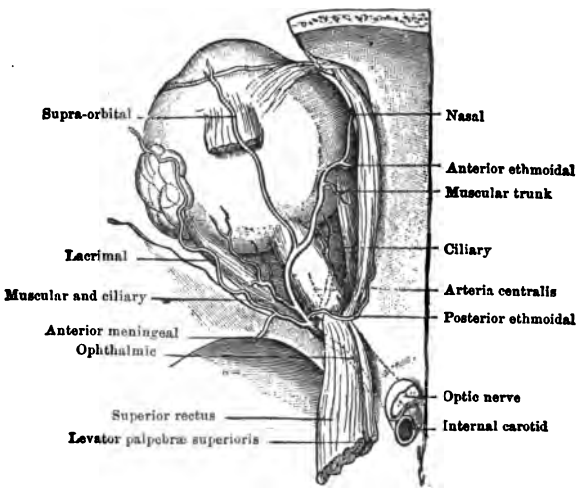


FIG. 161.

Opthalmic artery and branches. (*After Merkel and Kallius.*) (*Ball.*)

The ARTERIES of the GLOBE of the eye are:—

1. The *short ciliary,* enter through the sclerotic around the optic nerve, to supply the choroid and ciliary processes.

2. The *long ciliary arteries,* two in number, pierce the sclerotic, run forward between the choroid and sclerotic to the ciliary muscle, which they supply, and where they form an anastomotic circle about the iris.

3. The *anterior ciliary arteries,* five or six in number, enter the sclerotic in front, supply the ciliary processes, and anastomose about the iris.

4. The *arteria centralis retina,* supplies the retina, dividing into four or five branches, which enter as deeply as the inner nuclear layer.

The *other arteries* supplying the eye and its appendages are derived from the *ophthalmic* branch of the internal carotid (the same source as the ciliary arteries), the *anterior cerebral* branch of the internal carotid, and the *infraorbital* branch of the internal maxillary.

The branches of the ophthalmic are the

Lachrymal;
Supraorbital;
Anterior and posterior ethmoidal;
Palpebral;
Frontal;
Nasal. (For description see Arterial System.)

The *veins* of the eyeball emerge as the *venæ vorticosæ,* unite with the other veins to form two main trunks—the *ophthalmic* and *inferior ophthalmic* veins—to terminate in the cavernous sinus. The ophthalmic vein anastomoses freely with the angular vein, the commencement of the facial at the inner angle of the orbit.

The *nerves* of the eye and its appendages are *nerve* of *special sense,* the optic or second cranial; *motor nerves,* the third and fourth; branches of the fifth and sixth, and filaments from the sympathetic.

Sensory nerve, ophthalmic division of the trifacial, or fifth cranial (*vide* Cranial Nerves).

Sympathetic branches, derived chiefly from the ciliary ganglion, Meckel's ganglion, and the cavernous and carotid plexuses (*vide* Cranial Sympathetic Ganglion).

APPENDAGES OF THE EYE.

The appendages of the eye, or the *tutamina oculi,* include:—

The eyebrows *(supercilia),*	Lachrymal gland,
The eyelids *(palpebræ),*	Lachrymal sac,
Conjunctiva,	Nasal duct.

THE EYEBROWS are the elevated arches of skin surmounting the upper margins of the orbits, covered with short, thick hairs.

THE EYELIDS are two movable folds, covering and protecting the front of the eye. The upper lid is larger, longer, and most movable, being supplied with a special muscle—the levator labii superioris.

The lids are separated by an elliptical fissure—the *fissura palpebrarum*—and connected at their angles of junction by the *outer* and *inner canthi.*

On the nasal side the lids are separated by a triangular space—the *lacus lachrymalis*—at the outer angles of which are the *lachrymal papillæ,* surmounted by the *puncta lachrymalia,* the commencements of the lachrymal canal. The lacus lachrymalis is filled by the *coruncula lachrymalis,* a mass of follicles resembling the Meibomian glands, and covered by the conjunctiva.

The *structure* of the *eyelids,* from without inward, is as follows:—

Skin, subcutaneous areolar tissue, fibres of the orbicularis muscle, tarsal cartilage, fibrous membrane, Meibomean glands, vessels, and nerves;

The *skin* is thin, and attached by a very loose areolar tissue to the muscle beneath;

The fibres of the orbicularis are pale, thin, and act involuntarily;

The *tarsal cartilages* are two plates of firm connective tissue; the superior, the larger, is semilunar in shape, the inferior is elliptical. The inner margins are fixed to the orbit by tendo oculi;

The *fibrous membrane of the lids,* or *tarsal ligament,* passes over the anterior surface of the tarsal cartilage, being attached to its free margin below and to the margin of the orbit externally;

The *Meibomian glands,* about thirty in number in the upper, a few less in the lower lid, are arranged vertically on the inner surface of the cartilages; they are straight, sebaceous follicles, into which open a number of secondary follicles, terminating above in a blunt extremity, and opening below on the free margin of the lids by small foramina, corresponding to the number of tubules;

The *eyelashes,* or *cilia,* are arranged on the free border of the lids in two or three rows.

THE CONJUNCTIVA is the mucous lining membrane of the front of the eye. It consists of two portions—the *ocular,* reflected over the sclerotic and cornea, and the *palpebral* portion, lining the internal surface of the lids.

The *ocular* portion is loosely connected with the sclerotic, but over the cornea it becomes very thin, consisting only of the epithelial layer.

The *palpebral* portion is thick, highly vascular, and contains many papillæ. At the inner angle of the eye it forms a semilunar fold, the plica semilunaris—the rudiment of the nictitating membrane of birds, the *membrana nictitans.*

The point of reflection is called the *fornix conjunctivæ,* and the reflected portions the *superior* and *inferior palpebral folds.*

The lachrymal apparatus consists of the lachrymal gland, canals, sac, and nasal duct.

THE LACHRYMAL GLAND is an oval, glandular body, about the shape and size of an almond, situated in a depression in the upper surface of the orbit near the external angular process.

The anterior portion of the gland is sometimes described as a separate lobe—the *palpebral portion* of the *gland,* or *accessory gland* of *Rosenmüller.*

The gland is attached to the bony roof of the orbit by the *tarso-orbital fascia.*

The *ducts,* seven to ten in number, open upon the conjunctiva near its point of reflection by minute orifices arranged in a row.

The *lachrymal canals* commence at the puncta lachrymalia, at the summits of the papillæ lachrymales, and descend by two *canaliculi* to empty into the lachrymal sac.

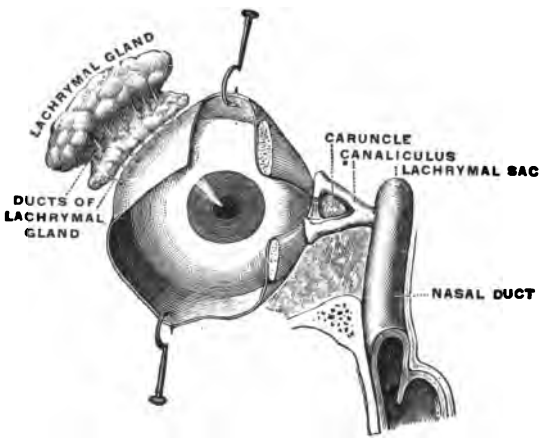


FIG. 162.

The lachrymal apparatus. (*Gerrish, after Testut.*) (*Eckley.*)

The superior canal descends obliquely inward and downward, while the inferior descends at first and then passes nearly horizontally inward.

THE LACHRYMAL SAC is the oval, dilated, upper portion of the nasal duct, lodged in a deep groove formed by the nasal process of the superior maxilla and the lachrymal bone. It is crossed by the tensor tarsi muscle, which acts as a compressor, and receives a fibrous expansion from the tendo oculi.

Its *structure* is made up of a fibrous elastic coat, lined by mucous membrane continuous with the nose and conjunctiva.

THE NASAL DUCT is a membranous tube about three-quarters of an inch in length, extending from the lachrymal sac to the inferior meatus of the nose, and lining the bony lachrymo-nasal

canal. It passes backward, downward, and outward, and is protected at its inferior extremity by a valve of mucous membrane—the *valve of Hasner.*

The mucous lining is continuous with that of the sac, but instead of having squamous epithelium it is ciliated in the duct.

THE EAR.

THE EAR—the organ of hearing—is contained in the petrous and mastoid portions of the temporal bone, and consists of three divisions,—external ear, middle ear or tympanum, and internal ear or labyrinth:—

1. External ear,
   - Auricle, or pinna,
   - External auditory canal or meatus;
2. Middle ear or tympanum,
   - Membrana tympani,
   - Tympanic cavity,
   - Mastoid sinuses,
   - Eustachian tube;
3. Internal ear or labyrinth,
   - Osseous portion,
     - Vestibule,
     - Semicircular canals,
     - Cochlea;
   - Membranous portion,
     - Utricle,
     - Saccule,
     - Semicircular canals,
     - Cochlea.

The external ear includes two parts, the auricle and the external auditory canal.

AURICLE, OR PINNA.

The external prominent portion is composed of cartilaginous segments, connected together by ligaments and muscles richly supplied with blood-vessels, nerves, and lymphatics, and covered with skin. It presents the following elevations and depressions:—

Fossa of the helix, a depression between the helix and antihelix;

Fossa of the antihelix, a depression above the bifurcation of the antihelix;

Tragus, the prominence in front of the concha, usually covered with hair;

Antitragus, a small, conical eminence behind the tragus, from which it is separated by the incisura intertragica;

Lobule, the soft, rounded portion depending below the antitragus;

Concha, a deep cavity, surrounded by the helix, and leading into the external meatus.

Muscles.—The muscles of the auricle include two sets, the extrinsic muscles, already described (*vide* Muscles), of which there are three—the attolens aurem, attrahens aurem, and retrahens aurem—and the intrinsic muscles, but slightly developed, of which there are two sets, four on the anterior surface of the auricle—the tragicus, antitragicus, helicis major, and

FIG. 163.

External, middle, and internal ear. 1, external ear; 2, middle ear; 3, internal ear; 4, pinna; 5, helix; 6, antihelix; 7, fossa navicularis; 8, fossa innominata; 9, tragus; 10, antitragus; 11, concha; 12, lobe; 13, meatus auditorius externus; 14, tympanic membrane; 15, promontory; 16, foramen rotundum; 17, posterior wall of the tympanum; 18, ossicula auditus; 19, Eustachian tube; 20, narrow canal; 21, vestibule; 22, semicircular canals, the superior, posterior, and horizontal; 23, ampullæ; 24, cochlea; 25, prominence caused by the scala vestibuli, 26, scala tympani. (*Boenning.*)

helicis minor—and two on the posterior surface, transversus auriculæ and obliquus auriculæ.

Arteries, auricular branch, from the occipital; posterior auricular, from the external carotid; and anterior auricular, from the temporal. The *veins* correspond to the arteries.

Nerves, auricular branch, from the pneumogastric; auriculotemporal branch, from the inferior maxillary; occipitalis major

and occipitalis minor; auricularis magnus, from the cervical plexus; and posterior auricular, from the facial.

AUDITORY CANAL, or *meatus auditorius externus,* is an osseo-cartilaginous canal, about one and one-fourth inches in length, extending from the concha to the tympanic membrane.

The *osseous portion* forms about two-thirds of the passage, and consists in greater part (anterior and lower) of a curved plate of bone—the *annulus tympanicus.*

The anterior and upper part of the ring present two spines—*spina tympanica, major* and *minor,* for the ligaments of the malleus.

The *sulcus tympanicus* is a furrow on the inner edge of the ring, for the attachment of the tympanic membrane.

The *cartilaginous portion* forms about one-third of the passage, and consists of the inverted cartilage of the tragus and concha, the upper and back part of which is deficient, the cleft being filled with fibrous tissue.

The *canal,* including the tympanic membrane, is lined throughout with skin, containing short hairs, vascular papillæ, sebaceous and *ceruminous glands.*

Arteries—branches of the internal maxillary, posterior auricular, and temporal branches of external carotid.

Nerves—from the auriculo-temporal branch, the inferior maxillary, and auricular branch of the pneumogastric.

MIDDLE EAR, OR TYMPANUM,

is an irregular cavity, situated between the auditory canal and the labyrinth, communicating with the pharynx through the Eustachian tube, and also with the mastoid cells. It contains a chain of movable bones, part of the chorda tympani nerve, and is filled with air. Its average diameters are about half an inch in height and width, and a line or two in depth from without inward. It is lined with mucous membrane, continuous with that of the Eustachian tube and mastoid cells, and which is reflected over all the tympanic contents. It is bounded by a roof, floor, and four walls, which present the following points:—

Roof, a very thin plate of bone, separates the tympanum from the cranial cavity, and corresponds to a depression on the anterior wall of the petrous bone;

Floor, forms the bottom of the jugular fossa, and presents:—

The *opening* for *Jacobson's nerve,* the tympanic branch of the glosso-pharyngeal.

Outer wall, formed by the tympanic membrane and the annulus tympanicus surrounding it:—

Iter chordæ posterius, gives entrance to chorda tympani nerve;
Iter chordæ anterius, or ***canal of Hugier,*** gives exit to same;
Glaserian fissure, above and in front of annulus tympanicus, receives the anterior ligament of the malleus, the long process of the malleus, and the tympanic artery;
Pouches of the membrana tympani, are two or three pockets formed by the doubling of the mucous membrane around the chorda tympani nerve.

Inner wall, separates the tympanum from the labyrinth:—

Fenestra ovalis, an oval window, leading to the vestibule, closed by the membrane to which the base of the stapes is attached;
Fenestra rotunda, a round window, leading to the scala tympani, but closed also by a membrane—***membrana tympani secundaria.***
Promontory, two grooves, marking the first turn of the cochlea, and separating the fenestræ ovalis and rotunda;
Pyramid, a small conical eminence behind the fenestra ovalis, which contains within it the stapedius muscle, and communicates with the aquæductus Fallopii.

Posterior wall:—

Openings of the mastoid cells, three or four in number, connect these sinuses with the tympanum.

Anterior wall, is a thin plate of bone, which separates the tympanum from the carotid canal.

Openings of the canal for tensor tympani, lies above and parallel with the canal for the Eustachian tube, and transmits the tensor tympani muscle;
Opening of Eustachian tube, the larger of the two, is separated from the former by a thin plate of bone, the ***processus cochleariformis.***

The tympanum is divided into two parts—the *attic of the tympanum* and the *atrium.* The former is situated on a plane directly above the atrium, and is bounded above by the tegmen, externally by auditory plate, and internally by prominence of the tympanum. On the outer part of the attic is a smooth surface called the *scute* (Leidy).

THE EUSTACHIAN TUBE is an osseo-cartilaginous canal, one and one-half to two inches in length, extending from the tympanum to the pharynx.

It is about one-third osseous and two-thirds cartilaginous, and lined with ciliated epithelium continuous with the pharynx

and tympanum. Its *pharyngeal orifice* is trumpet-shaped, and opens at the side of the pharynx, behind the inferior meatus.

Muscles of the *Eustachian tube*:—

Tensor palati (tensor veli), the most important has been described (*vide* Palatal Region). Its action is to pull the anterior wall of the tube outward and downward, and widen the canal.

Internal Pterygoid (*vide* Muscles).—Some fibres are inserted into the floor of the tube. It acts as tensor of the fascia.

Ligamenta salpingo-pharyngeal, arises from the superior and middle constrictors of the pharynx, and is inserted by three to five tendinous cords into the pharyngeal orifice of the tube. Action, opens the tube.

Arteries of Eustachian Tube.—Pharyngeal from the external carotid, middle meningeal from the internal maxillary, and small branches from the internal carotid.

Nerves, by branches from the glosso-pharyngeal, inferior maxillary, otic ganglion, and facial nerve.

MEMBRANA TYMPANI is a thin, parchment-like membrane, stretched upon the annulus tympanicus, forming the bottom of the external auditory canal, and separating it from the tympanum. It is placed obliquely downward and inward at an angle of 45°.

Structure.—Its three layers are:—

External or *cuticular,* derived from the skin of the meatus;

Middle or *fibrous,* consisting of two sets of fibres, radiating and circular, the latter forming a tendinous ring around the margin;

Internal or *mucous,* continuous with the mucous membrane of the tympanum.

Its *outer surface* presents:—

Manubrium of *malleus,* projecting downward and backward;

Processus gracilis of *malleus,* projecting outward above the manubrium;

Umbo, a depression of the membrane formed by the lower end of the manubrium;

Yellow spot, the cartilaginous end of the manubrium; *pyramid of light,* a triangular cone of reflected light in the antero-inferior quadrant of the membrane.

Inner surface (*vide* Outer Wall of Tympanum).

Arteries, tympanic branch of inferior, branch from the internal carotid.

Nerves, from the superficial temporal branch of the trifacial, and from the tympanic plexus.

OSSICLES OF THE TYMPANUM.

The small bones of the tympanum are three in number, and connect the membrana tympani with the membrane closing the fenestra ovalis. They are the

1. *Malleus,* or *hammer,* consists of a head, neck, *manubrium* or handle, processus gracilis, and processus brevis. The *manubrium* is attached to the membrana tympani, and has the tendon of the tensor tympani attached. *Processus gracilis* is lodged in the Glaserian fissure.

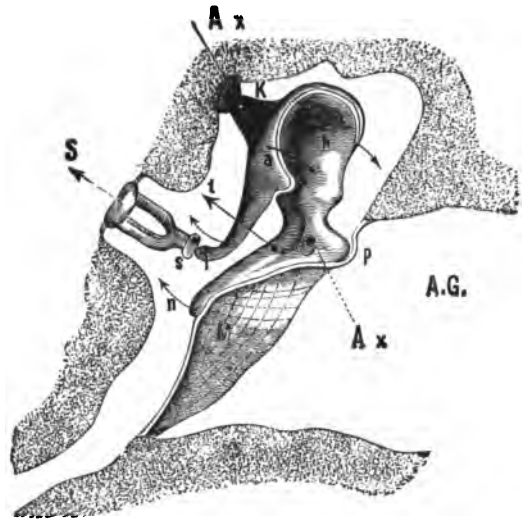


FIG. 164.

The auditory ossicles. A. G., external meatus; M, membrana tympani; n, handle of the malleus and its short process (p); h, head of the malleus; a, incus; K, its short process, with its ligament; l, long process; s, os orbiculare; S, stapes; Ax, Ax, the axis of rotation of the ossicles, shown in perspective; t, line of traction of the tensor tympani. The other arrows show the movements of the ossicles when the tensor contracts. (*Boenning.*)

2. *Incus,* or *anvil,* consists of a body and long and short processes. The body articulates with the malleus and the long process by means of a rounded process. The *os orbiculare* articulates with the head of the stapes.

3. *Stapes,* or *stirrup,* has a head, neck, two branches (or crura) which unite into a cross-piece or base. The *neck* has inserted into it the stapedius muscle, and the *base* is fitted to the fenestra ovalis.

Ligaments of the *Ossicles:*—

Lig. mallei anterius, extends from the neck of the malleus to the outer wall of the tympanum;
Lig. mallei suspensorium, suspends the head of the malleus to the roof;
Lig. incudi posticum, attaches the short process to the posterior wall;
Lig. incudi suspensorium, suspends the incus to the roof;
Lig. stapedi annularum, connects the base to the margin of the fenestra ovalis.

Muscles.—The tensor tympani, stapedius.

Tensor tympani (already described).

Stapedius arises from the hollow of the pyramid on the inner wall, and its tendon is inserted into the neck of the stapes. Nerve from the tympanic branch of facial.

Arteries:—

Tympanic branch of internal maxillary;
Stylo-mastoid branch of posterior auricular;
Petrosal branch of middle meningeal;
Tympanic branch from internal carotid;
Branch from ascending pharyngeal.

Veins accompany the corresponding arteries and empty into middle meningeal and pharyngeal.

Nerves:—

Chorda tympani, from the facial, enters the iter chordæ posterius, crosses the tympanum between the long process of the incus and the handle of malleus, and makes its exit at the iter chordæ anterius;

Tympanic branch of *glosso-pharyngeal* (Jacobson's nerve) enters the floor, supplies the fenestræ and mucous membrane of tympanum and Eustachian tube;

Tympanic branch from facial to the stapedius;

Branch from the otic ganglion to the tensor tympani.

The *tympanic plexus* is formed upon the surface of the promontory, from the following nerves:—

Jacobson's nerve, tympanic branch of the glosso-pharyngeal;
Branch of the superficial petrosal, from the facial;
Branches from the carotid plexus of the sympathetic.

INTERNAL EAR, OR LABYRINTH.

The internal ear, the essential part of the organ of hearing, consists of three complex cavities within the petrous portion of the temporal bone, filled with fluid, the perilymph, and contain-

ing a membranous sac filled also with fluid, the endolymph, which receives the distributions of the auditory nerve.

Its divisions are:—

Osseous portion,	**Vestibule,** **Semicircular canals,** **Cochlea;**
Membranous portion,	**Utricle,** **Saccule,** **Semicircular canals,** **Cochlea.**

VESTIBULE, is a common cavity of communication between the bony parts of the internal ear. It is situated between the tympanum without, the cochlea behind, and the semicircular canals in front, and measures one-fifth of an inch in its antero-posterior and vertical diameters, and less from without inward. It presents:—

Fenestra ovalis on its outer wall, closed by the stapes and its ligament;

Fovea hemispherica, a circular depression on its inner wall for the saccule, and perforated by the *macula cribrosa,* for the vestibular filaments of the auditory nerve;

Orifice of the *aquæductus vestibulæ,* on the inner wall for the transmission of a small vein;

Eminencia pyramidalis, a vertical ridge on the inner wall separating the two foræ;

Fovea semi-elliptica, in the roof lodges the utricle.

SEMICIRCULAR CANALS are three canals, forming each two-thirds of a circle one-twentieth of an inch in diameter, and named, from their position, the superior, posterior, and external. They are placed nearly at right angles to each other, and open into the vestibule by five apertures—two extremities uniting to form one.

The *superior* and *posterior* are both vertical, the former being more anterior.

The *external* is placed horizontally, its arch directed backward.

Ampullæ, are the dilated, flask-shaped extremities of the tubes, and are about one-tenth of an inch in diameter.

THE COCHLEA resembles closely a common snail's shell, placed with the base corresponding to the bottom of the meatus auditorius internus, and its apex directed outward and forward. It consists of two parallel tubes one and one-half inches in length, one-tenth of an inch in diameter, wound spirally for two and one-half turns around a central pillar—the modiolus.

The *modiolus,* or *columella,* is broad at the base, but tapers gradually toward the apex, where it terminates within the last turn or cupola in the infundibulum, a funnel-shaped lamina of bone. Its interior is traversed by numerous canals for vessels and nerves, one of which—the *canalis centralis modioli*—runs nearly the whole length, and transmits the *arteria centralis modioli.*

Lamina spiralis, the partition between the two tubes, consists of two thin laminæ of bone filled with cancellous tissue—

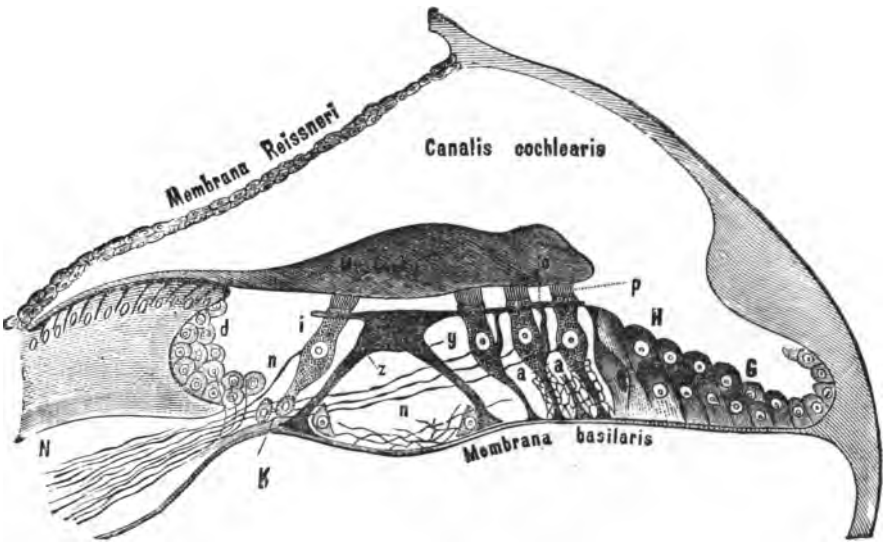


FIG. 165.

Organ of Corti. N, cochlear nerve; K, inner and, P, outer hair-cells; n, nerve-fibrils terminating in P; a, a, supporting cells; d, cells in sulcus spiralis; z, inner rod of Corti; Mb. Corti, membrane of Corti, or the membrana tectoria; o, the membrana reticularis; H, G, cells filling up the space near the outer wall. (*Boenning.*)

lamina spiralis ossea—projecting from the modiolus half-way to the outer wall, the lamina being completed by the *membrana basilaris.* The osseous lamina terminates in the cupola in a hook-like process—the *hamulus.*

The *spiral canal,* between the modiolus and the outer wall, is divided by the lamina spiralis ossea and membrana basilaris into two canals, or *scalæ*—the upper scala vestibuli, and the lower scala tympani.

The first turn of the spiral canal presents three openings:—

1. *Fenestra rotunda,* a circular aperture communicating with the tympanum, and closed by the *membrana* tympanum secondaria.

2. *Fenestra ovalis,* an oval opening, communicating with the vestibule.

3. *Aquæductus cochlearis,* a small foramen opening on the inferior surface of the petrous portion of the temporal bone, and transmitting a small vein from the cochlea to the jugular vein.

Scala vestibuli, begins at the fenestra ovalis, and ascends in a spiral course above the lamina spiralis and membrana basilaris, to communicate with the scala tympani, through the helicotrema within the vestibule. It contains perilymph.

Scala tympani begins at the fenestra rotunda, and ascends in a spiral course below the scala vestibuli, from which it is separated by the osseo-membranous lamina. It also contains perilymph.

Helicotrema is an opening within the cupola, by which the two scala communicate. It is formed by a deficiency of the osseous lamina.

Canalis spiralis modioli, is a small canal which winds around the modiolus at the attachment of the osseous laminæ. It contains a gangliform swelling—*ganglion spirale*—from which nerves pass to the organ of Corti.

THE MEMBRANOUS LABYRINTH corresponds closely to the osseous, the vestibule consisting of two membranous sacs—the utricle and saccule—communicating with each other, and the former receiving the five openings of the membranous semicircular canals, the latter communicating with the membranous cochlea through the *canalis reuniens.* The membranous labyrinth is surrounded everywhere with perilymph, filled with endolymph, and is composed of three coats—an outer fibrous layer, middle or tunica propria, and inner epithelial layer.

Utricle, the larger of the two, is an elliptical sac lodged in the fovea hemi-elliptica. The semicircular canals communicate with it by five openings. Its wall is the thickest near the crista vestibuli, where the filaments of the nerve enter, the *macula acoustica.*

Saccule, is a hemispherical sac lodged in the fovea hemispherica. It communicates with the cochlea through a small duct—the canalis reuniens.

The *otoliths,* or *otoconia,* are small masses of crystals of lime carbonate, contained in the inner wall of the utricle and saccule opposite the distribution of the nerves.

Semicircular Canals.—These are three membranous tubes corresponding exactly in shape, number, and form to the bony canals in which they are contained. They are surrounded everywhere with perilymph, except at the ampullæ, where they are in contact with the bony canals. The inner, or epithelial layer of the membrane in the ampullæ, is covered with columnar ciliated epithelium—*auditory hairs.*

THE MEMBRANOUS COCHLEA begins at the base and ascends in a spiral course within the osseous cochlea to terminate in the cupola. It includes only the canalis cochleæ—a part of the scala vestibulæ. As before stated, the membrana basilaris extends from the margin of the lamina spiralis ossea to the outer wall of the cochlea, dividing the cavity into the two scalæ—the scalæ vestibulæ above, the scalæ tympani below. The former is again subdivided by the membrane of Riessner into two parts, the outer of which forms the *canalis cochlea,* or *scala media*—the membranous cochlea proper—on the floor of which is the organ of Corti covered by the membrana tectoria. The scalæ are lined with periostium, and filled with perilymph. The scala tympani ends at the fenestra rotunda, but the scala vestibula communicates freely with the vestibula.

Limbus laminæ spiralis is the periosteal margin of the lamina spiralis ossea, and consists of an upper lip—the *labium vestibulare*—and a lower lip—the *labium tympanicum*—separated by a groove—the *sulcus spiralis.*

Membrana basilaris extends from the labium tympanicum to the outer cochlear wall, to which it is attached by the *ligamentum spirale* of Henle.

Membrane of *Reissner* arises from the middle of the vestibular lamina and passes obliquely at an angle of 40° to the outer cochlear wall, separating the canalis cochleæ from the scala vestibula.

Canalis cochlea extends as a spiral sac closed at both ends through the osseous cochlea, and contains the most important part of the labyrinth—the ultimate distribution of the auditory nerve in the organ of Corti. It is triangular on section, the membrana basilaris forming the base, the membrane of Riessner the inner side, and the periosteum of the cochlea its outer side.

Membrana tectoria, or *membrane of Corti,* commences as a delicate membrane, at a point between the origin of the membrane of Riessner and the labium vestibule, and arches over to the outer cochlear wall, inclosing the organ of Corti, but not in contact with it.

ORGAN OF CORTI consists of two sets of pillars—the inner and outer rods of Corti—extending upward upon the vestibular

surface of the membrana basilaris, and forming a series of arches. Between the bases of the arches is the *zona arcuata.* There are over three thousand arches, and within them is formed a tunnel extending the entire length of the lamina spiralis terminating at the hamular process.

Inner rods of Corti, rest upon the basilar membrane. Their upper extremities resemble the proximal extremity of the ulna, and each has on its inner side a row of epithelial cells—the *inner hair-cells.*

Outer rods of Corti, are attached in a similar manner at the bases, and their extremities each resemble the head and bill of a swan, the former fitting into the cavity in the inner rods. On the outer side are four rows of ciliated cells—the *outer hair-cells.*

Reticular membrane, or *lamina reticularis,* is a delicate complex net-work of *phalanges*—fiddle-shaped structures—extending from the inner rods to the external row of the outer hair-cells.

THE INTERNAL AUDITORY CANAL, is a short canal about one-third of an inch in length, extending outward from the meatus auditorius internus, on the posterior surface of the petrous portion of the temporal bone to terminate at a vertical, perforated plate—the *lamina cribrosa.* This plate is divided by a horizontal ridge into a lower and upper portion. The lower is perforated by numerous foramina for passage of the auditory artery and branches of the auditory nerve, some of which are arranged into a spiral-shaped depression, called the *tractus spiralis foraminulentus;* the upper has one large opening—the commencement of the aquæductus Fallopii for portio dura, or seventh nerve.

Auditory Nerve.—The auditory nerve enters the internal auditory meatus in company with the facial, and at the bottom divides into two branches—the vestibular and cochlear.

Vestibular nerve subdivides into three branches, as follows:—

Superior, distributed to the utricle and ampullæ of the superior and external semicircular canals;

Middle, enters the bottom of the fovea hemispherica, and is distributed to the saccule; and the

Inferior, is distributed to the ampulla of the posterior semicircular canal.

Cochlear nerve, ascends in the canals in the modiolus, and divides into numerous branches which pass between the plates of the lamina spiralis ossea, forming a plexus which contains the ganglia spirale, from which filaments are distributed to the outer and inner hair-cells of the organ of Corti.

Arteries of Labyrinth:—

Internal auditory, from the basilar, divides into vestibular and cochlear branches, which accompany the corresponding nerves;

Stylo-mastoid, from the posterior auricular, enters through the stylo-mastoid foramen.

THE TONGUE.*

The tongue is the organ of the sense of taste, and lies in the floor of the mouth. It is composed of a mass of muscles, the free surface of which is entirely invested with mucous membrane. It consists of three parts:—

Base, or *root,* attached to the hyoid bone, the epiglottis and the soft palate;

Body, the back or dorsum of which is marked by a median line or *raphé,* terminating behind in a cavity—the *foramen cæcum;*

Apex, or *tip,* narrow and pointed, directed forward.

The *mucous membrane* resembles skin, consisting of a *corium* or *mucosa,* containing numerous papillæ, and covered with epithelium. The papillæ are most numerous over the anterior two-thirds of the dorsum, and consist of three varieties:—

Circumvallate, or largest, about ten in number, about one-twelfth inch wide, are arranged at the back part of the dorsum like the letter **V,** with the apex directed backward;

Fungiform, or medium, are scattered over the organ, especially at the tips and sides;

Filiform, conical, or smallest, are distributed over the anterior two-thirds of the dorsum.

Mucous and serous glands and simple papillæ, such as are found in the skin, are also present.

Taste bulbs, or *taste goblets,* minute, flask-shaped bodies, about one three-hundredths of an inch in length, are situated in the circumvallate and fungiform papillæ.

Arteries, are branches of the lingual, facial, and ascending pharyngeal.

1. *Nerves.—Hypoglossal,* the principal motor nerve.

2. *Lingual branch of glosso-pharyngeal,* the special nerve of taste.

3. *Lingual branch of the trifacial,* to sides and anterior part; nerve of common sensation.

4. *Chorda tympani,* probably nerve of special sense.

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* *Vide* **Lingual Muscles, page 119.**

5. *Superior laryngeal,* filaments from its internal branch to the base.

THE SKIN AND APPENDAGES.

The skin, besides being the special organ of the sense of touch, is an absorbing and excretory organ, and protects the underlying structures.

It consists of two layers—the epidermis or cuticle, and the derma or true skin. The appendages are the nails, hair, sudoriferous and sebaceous glands, and their ducts.

The *epidermis,* or *cuticle,* is an epithelial structure consisting of four layers:—

1. *Rete Malpighii,* the deepest layer, in contact with the corium, is composed of several layers of round or polyhedral epithelial cells. This layer is pigmented in the negro and other dark races.
2. *Granular layer,* is a single layer of compressed, spindle-shaped cells.
3. *Stratum lucidum,* are still more compressed into scales.
4. *Stratum corneum,* several layers of horny scales.

The *derma,* or true skin, has two layers, the reticular or deeper, and the papillary or superficial.

Reticular layer is composed of interlacing bands of white fibrous tissue, mixed with yellow elastic fibres, and some unstriated muscular fibres where hairs are found, together with blood-vessels, lymphatics, and nerves.

Papillary layer is covered with minute, vascular, highly sensitive elevations—the papillæ—from one one-hundredth to one two-hundred-and-fiftieth of an inch in diameter. These papillæ are in places arranged into parallel curved ridges, and have in the most sensitive situations some one of the "peripheral end organs" (already described) added to their structure.

NAILS are horny plaques of modified epidermis, firmly adapted to the derma on the dorsal surfaces of the terminal phalanges. Each nail is firmly implanted by its *root* into a fold of skin.

The *matrix* is the derma beneath the body, which is vascular and highly sensitive.

The *lunula* is the white, less vascular portion of the matrix near the root.

HAIRS are a cylindrical modification of the epidermis, and consist of a root imbedded in the skin, a shaft, and a point.

Root is lodged in a pouch-like involution of epidermis—the *hair-follicle.* This is composed of an inner or cuticular and an

outer or dermic layer, and presents at the bottom a vascular papilla, on which the hair rests, and from which it grows.

Shaft, consists of a pith or medulla in the centre, surrounded by a fibrous part containing pigment, and covered with a layer of scaly epithelium.

Point, contains the two latter elements, but has no medulla.

SEBACEOUS GLANDS are minute, glandular bodies, situated in the substance of the corium, and each opening by a single duct into a hair-follicle, or upon the surface of the skin. They are most abundant where hairs are found. The Meibomian glands in the eyelids are the largest.

SUDORIFEROUS or SWEAT GLANDS are minute, reddish, glandular bodies, situated usually in the subcutaneous connective tissue, each consisting of a single convoluted tube. Each gland opens on the surface of the skin.

SURGICAL ANATOMY.

THE TRIANGLES OF THE NECK.

THE general outline of the neck is somewhat quadrilateral. *Bounded* in front by the median line, behind by the trapezius muscle, above by the lower border of the body of the maxilla, and below by the clavicle. It is divided by the sterno-mastoid muscle running obliquely through it into two large triangles, an anterior and a posterior triangle. These are again subdivided by the crossing of the omo-hyoid muscle into two smaller triangles each. The anterior into the superior and inferior carotid triangles, and the posterior into the occipital and subclavian triangles. The digastric muscle, at the upper part of the anterior triangle, separates a triangular space called the submaxillary triangle.

The *anterior triangle* of the neck is *bounded* as follows:—

Front, median line of the neck;

Behind, anterior border of the sterno-mastoid muscle;

Above, lower border of the body of the lower jaw, and a line from its angle to the mastoid process, forming the base of the triangle;

Below, the top of the sternum, forming the apex.

The *floor* is formed by the sterno-hyoideus, sterno-thyroideus, thyro-hyoideus, inferior and middle constrictors of the pharynx, the anterior belly of the digastricus, the mylo-hyoideus, stylo-hyoideus, and hyoglossus muscles. The *roof* is formed by the skin, superficial fascia, platysma myoides, and deep fascia.

The *inferior carotid triangle* is the most inferior subdivision of the anterior triangle, and is *bounded* as follows:—

Front, median line of the neck;

Behind, anterior border of the sterno-mastoideus;

Above, anterior belly of the omo-hyoideus;

Below, the apex of the anterior triangle.

It *contains* the following structures:—

Thyroid gland and lower part of the trachea and larynx;

Inferior thyroid and common carotid arteries;

Inferior thyroid and internal jugular veins;

Pneumogastric, recurrent laryngeal, descendens noni, communicans noni, and sympathetic nerves.

The *superior carotid triangle* is the middle subdivision of the anterior triangle of the neck, and has the following boundaries:—

Above, posterior belly of the digastricus;
Below, anterior belly of the omo-hyoideus;
Behind, anterior border of the sterno-mastoideus.
It *contains* the following structures:—
Termination of the common carotid;

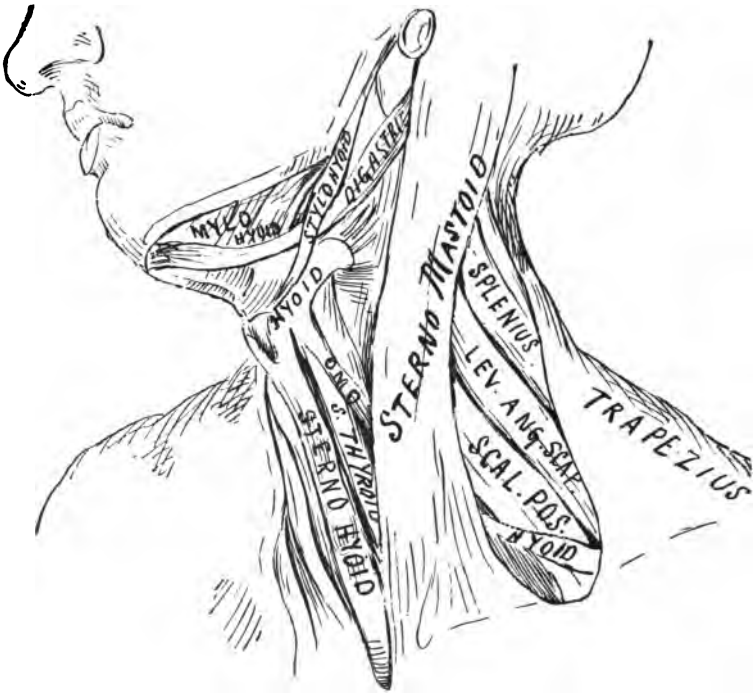

FIG. 166.

Triangles of the neck. (*Boenning.*)

The internal carotid;
The external carotid, and the following branches:—
Superior thyroid, lingual, facial, ascending pharyngeal, and occipital;
The internal jugular vein, and the following tributaries:—
Lingual, facial, superior thyroid, pharyngeal, and occasionally the occipital;

The pneumogastric, superior laryngeal, external laryngeal, descendens noni, spinal accessory, hypoglossal, and sympathetic nerves.

The *submaxillary triangle* is the most superior of the subdivisions of the anterior triangle, and has the following boundaries:—

Above, the lower border of the body of the jaw, and the imaginary line behind;

In front, the median line of the neck;

Behind, the posterior belly of the digastricus.

It *contains* the following structures:—

External carotid, internal carotid, facial, submental, mylohyoidean arteries;

The internal jugular, the commencement of the external jugular, branches of the anterior jugular, and the facial vein and its branches;

The inframaxillary branches of the facial nerve, the ascending branches of the superficial cervical nerve, and the pneumogastric and glosso-pharyngeal and mylo-hyoid nerves;

Portions of the parotid and submaxillary glands, and also submaxillary lymphatic glands and vessels.

The *posterior triangle* of the neck occupies the space behind the posterior border of the sterno-mastoideus, and is *bounded* as follows:—

Front, posterior border of the sterno-mastoideus;

Behind, anterior border of the trapezius;

Below, upper border of the middle third of the clavicle, forming its base;

Above, the occiput, forming the apex.

Its *floor* is formed from above downward, by the following muscles:—

Splenius capitis, levator anguli scapuli, scalenius medius, scalenius posticus, and the upper portion of the serratus magnus.

Its *roof* is formed by the superficial and deep fascia, and below by the platysma myoides.

It *contains* the following structures:—

The transversalis colli artery and vein;

Spinal accessory and superficial plexus of the cervical nerve;

Lymphatic glands and vessels.

The *subclavian triangle,* or the inferior division of the posterior triangle, is *bounded*—

In front by the margin of the sterno-mastoideus, behind by the posterior belly of the omo-hyoideus, below by the clavicle.

It *contains* the following structures:—

The subclavian, transversalis colli, and transversalis humeri or suprascapular arteries;

The transversalis colli, suprascapular, and external jugular veins;

The descending branches of the superficial cervical plexus, and the brachial plexus of nerves;

Lymphatic nerves and vessels.

Triangle in Front of the Elbow-joint.

Bounded—

Externally, by supinator longus;

Internally, by pronator radii teres;

Base, above, by a line (imaginary) down through the condyles;

Apex, below, by crossing of supinator longus and pronator radii teres.

It is *covered in* by skin, superficial fascia, and bicipital fascia; the *floor* is formed by oblique fibres of the supinator brevis and lower part of brachialis anticus muscles.

It *contains*:—

From within outward, median nerve, brachial artery, and venæ comites, biceps tendon, and musculo-spiral nerve.

Scarpa's Triangle

is a large triangular space situated in the upper part of the anterior surface of the thigh, through which the femoral vessels descend. It is *bounded*—

Externally by sartorius, internally by adductor longus, above by Poupart's ligament; below, apex is formed by crossing of bounding muscles.

It is *covered in* by skin, superficial fascia lata, and cribriform fascia, and its *floor* is formed by the following from without inward: iliacus, psoas, pectineus, and portion of adductor brevis muscles.

It *contains*:—

The femoral artery (with its profunda and cutaneous branches), inclosed in the femoral sheath, femoral vein (joined by profunda and long saphenous veins), anterior crural nerve and its branches [from within outward being vein, artery, and nerve], deep lymphatic glands and vessels, and adipose tissue.

Axilla.

This is a pyramidal space between the upper and lateral part of the chest and the inner side of the arm. It is *bounded*—

In front, by the pectoralis major and minor muscles; behind, by latissimus dorsi, teres major, and subscapularis; in-

ternally, by the upper four ribs and intercostal and upper part of serratus magnus muscles, and its apex is directed upward, and is formed by the space between the first rib, clavicle, and upper border of the scapula, and its base by the skin and axillary fascia stretched across between the lower borders of the pectoralis major and latissimus dorsi muscles.

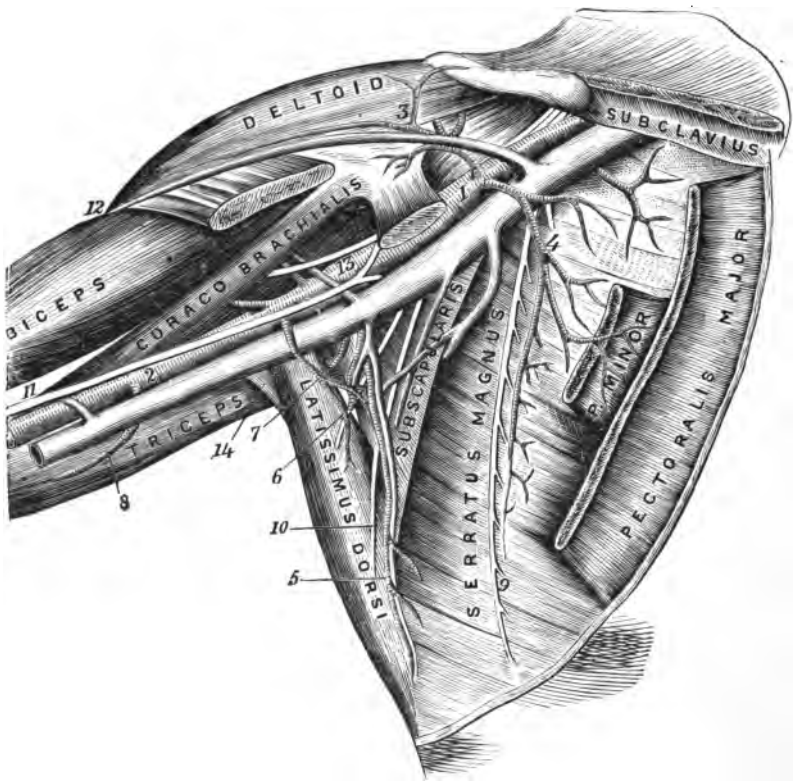

FIG. 167.

The axilla. 1, axillary artery; 2, brachial artery; 3, acromio-thoracic artery; 4, superior thoracic artery; 5, subscapular artery; 6, dorsalis scapulæ artery; 7, posterior circumflex artery; 8, superior profunda artery; 9, posterior thoracic nerve; 10, long subscapular nerve; 11, median nerve; 12, cephalic vein; 13, musculo-cutaneous nerve; 14, teres major muscle. (*Boenning.*)

It *contains:*—

The axillary artery and vein, and their branches; the brachial plexus of nerves, and the branches given off below the

clavicle; branches of the intercostal nerves; ten or twelve lymphatic glands, and a quantity of loose adipose and areolar tissue.

Popliteal Space.

The popliteal space is a lozenge-shaped space situated at the back of the knee, and forms the *ham*. It is *bounded*—

Externally, above the joint, by the biceps; below the joint, by outer head of gastrocnemius and plantaris; internally, above the joint, semitendinosis, semimembranosis, gracilis, and sartorius; below the joint, by inner head of the gastrocnemius.

It is *covered in* by the skin, superficial fascia, and fascia lata.

Its *floor* is formed by the lower part of the posterior surface of the femur, the ligamentum posticum Winslowi, and the popliteus muscle and its fascia.

It *contains*:—

The popliteal artery and branches; popliteal vein receiving the external saphenous vein (vein to the outer side); internal and external popliteal nerves and branches; articular branch of obturator nerve; branch of small sciatic nerve; four or six lymphatic glands, and a quantity of adipose and areolar tissue.

ANATOMY OF HERNIA.

Hernia is the protrusion of any part of a viscus from its natural cavity through the enclosing walls of the cavity. As usually understood, it refers to the protrusion of the intestine or mesentery, or both, from the abdominal cavity. The most common forms are:—

External or oblique inguinal hernia;
Internal or direct inguinal hernia;
Femoral hernia;
Umbilical hernia.

1. OBLIQUE INGUINAL HERNIA escapes from abdominal cavity at the internal abdominal ring, carrying before it a pouch of peritoneum, descends along the inguinal canal in front of the cord, and emerges at the external opening. The anatomical parts concerned are the inguinal canal, with its internal and external abdominal rings, the transversalis fascia (*vide* Fascia), the peritoneum (*vide* Peritoneum), and Poupart's ligament.

The *inguinal* or *spermatic canal* is about one and a half inches in length, extending from the internal abdominal ring to the external abdominal ring. It serves for the passage of the

spermatic cord in the male, and the round ligament with its vessels in the female. Its *boundaries* are:—

In front, the tendon of the external oblique muscle, the lower border of the internal oblique, and a small portion of the cremaster muscle;

FIG. 168.

Dissection of the inguinal canal: A, external oblique; B B, internal oblique; C, transversalis; D, conjoined tendon; E, rectus abdominis with sheath opened; F, fascia transversalis; H, cremaster; I, infundibular fascia.

Behind, the fascia transversalis, the conjoined tendon of the transversalis and internal oblique muscles, and the transversalis fascia;

Above, by the arched border of the internal oblique and transversalis muscles;

Below, by Poupart's ligament.

The *internal abdominal ring* is an oval opening in the transversalis fascia about half an inch above Poupart's ligament, midway between the symphysis pubis and the anterior superior spinous process of the ilium. It is *bounded*—

Above and externally by the arched fibres of the transversalis muscle; below and internally by the deep epigastric vessels.

It transmits a funnel-shaped fascia from its margins, the infundibuliform fascia.

The *external abdominal ring* is a triangular opening between the two pillars in the aponeurosis of the external oblique muscle, to the outer side and just above the spine of the pubes. It is about half an inch wide and one inch long, and is *bounded*—

Above, by the intercolumnar fascia; below, by the spine and crest of the os pubis, and on either side by the pillars or columns of the ring formed by the free margins of the aponeurosis of the external oblique.

From the margins of the external abdominal ring arises the intercolumnar fascia.

Poupart's ligament, or the *femoral arch,* is the rounded lower fibrous margin of the external oblique muscle, extending between the anterior superior spine of the ilium and the spine of the pubes. The portion of the aponeurosis which is inserted into the pectineal line has received the name of Gimbernat's ligament.

The epigastric artery holds a very important anatomical relation to the inguinal canal and internal abdominal ring. It ascends between the peritoneum and transversalis fascia to reach the sheath of the rectus muscle along the inner and lower margin of the internal ring and beneath the spermatic cord.

The coverings of oblique inguinal hernia are:—

1. Skin;
2. Superficial fascia;
3. Intercolumnar fascia;
4. Cremaster muscle;
5. Fascia transversalis, or infundibuliform fascia;
6. Subserous connective tissue;
7. Peritoneal sac.

2. DIRECT INGUINAL HERNIA escapes through the abdominal wall, within Hesselbach's triangle, internal to the epigastric artery, and through the external abdominal ring, pushing before it a pouch of peritoneum.

Hesselbach's triangle is a space situated at the lower anterior part of the abdominal wall on either side. It is bounded as follows:—

Externally, epigastric artery;

Internally, the outer margin of the rectus abdominis muscle;

Below, Poupart's ligament, forming its base. The structures forming the abdominal wall at this cavity are, from without inward:—

1. Skin;
2. Superficial fascia;
3. Intercolumnar fascia;
4. Conjoined tendon of the transversalis and internal oblique;
5. Fascia transversalis;
6. Subserous tissue;
7. Peritoneum.

The anatomical parts concerned in direct inguinal hernia are the same as those in the indirect, already given. The coverings of direct inguinal hernia are those just given.

3. FEMORAL HERNIA escapes through the femoral ring, carrying before it a pouch of peritoneum, descends through the femoral canal and emerges through the saphenous opening in the fascia lata. The anatomical parts concerned in this hernia are:—

The femoral ring, the femoral or crural canal, the septum crurale, crural sheath and deep crural arch, and the saphenous opening.

The *femoral* or *crural ring* is an oval opening, about an inch and a half in diameter, larger in the female and situated below Poupart's ligament, between the inner side of the femoral vein and the margin of Gimbernat's ligament. It is the abdominal opening of the *femoral canal* and it is closed in the recent state by the septum crurale and a small lymphatic gland. It is *bounded*—

In front, by the deep femoral arch and Poupart's ligament;

Behind, by the pubes, covered by the pubic portion of the fascia lata and the pectineus muscle;

Externally, by the femoral vein, from which it is separated by a fibrous septum;

Internally, by the deep femoral arch, Gimbernat's ligament, the transversalis fascia, and the conjoined tendon.

The *femoral canal* is a space from a quarter to half an inch in length, extending from Gimbernat's ligament to the upper margin of the saphenous opening. Bounded above by the femoral ring and below by the saphenous opening. It is the innermost compartment of the femoral sheath.

Anterior wall—transversalis fascia, covered by the falciform process of the fascia lata;

Posterior wall—iliac fascia and pubic portion of the fascia lata;

External wall—fibrous septum of the femoral vein;

Internal wall—Gimbernat's ligament, deep crural arch, and the junction of the iliac and transversalis fascia.

The septum crurale is a layer of dense areolar tissue, supporting small lymphatic glands and closing in the femoral ring. It is perforated by numerous lymphatic vessels, and forms a barrier to the escape of hernia at this point.

The *crural* or *femoral sheath* is a prolongation downward of the fascia lining the abdomen (transversalis fascia in front, iliac fascia behind the vessels), closely adhering to the femoral vessels to about an inch below the saphenous opening. Its upper part is funnel-shaped and its lower part continuous with the sheath of the vessel. It is divided by septa into three compartments; in the outer is lodged the femoral artery; the middle is occupied by the femoral vein; and the innermost, the *femoral canal,* is empty, or occupied by a lymphatic gland. Its outer border is pierced by the genito-crural nerve, its inner by the internal saphenous vein.

The *deep femoral arch* is a fibrous thickening of the transversalis fascia which forms the anterior wall of the femoral sheath.

The *saphenous opening* is an oval aperture of half an inch in width, an inch and a half in length in the upper and inner part of the fascia lata, between its two divisions, the iliac and pubic portions. It is bounded externally by the falsiform process of Burns, internally by the pubic portion of the fascia lata, which curves upward behind the saphenous vein. The opening is covered externally by the cribriform fascia and the skin.

The coverings of femoral hernia are:—

1. Skin;
2. Superficial fascia;
3. Cribriform fascia;
4. Femoral sheath, or fascia propria;
5. Septum crurale;
6. Peritoneal sac.

ISCHIO-RECTAL REGION AND PERINEUM.

The outlet of the pelvis is a lozenge-shaped space divided by an imaginary line drawn in front of the anus, transversally between the front part of the tuber ischii, into two parts, the ischio-rectal region behind and the perineum in front.

The *ischio-rectal region* contains the external and internal sphincters, the corrugator cutis ani and the ischiorectal fossa. The latter is a pyramidal cavity, its apex reaching to the junction of the obturator and anal fascia, and its base formed by the skin. It is *bounded*—

Behind, by the edge of the great sacro-sciatic ligament and gluteus maximus and coccygeus muscles; internally, by the levator ani, covered by the anal fascia, sphincter ani, and coccygeus muscle; externally, by the tuber ischii and obturator fascia.

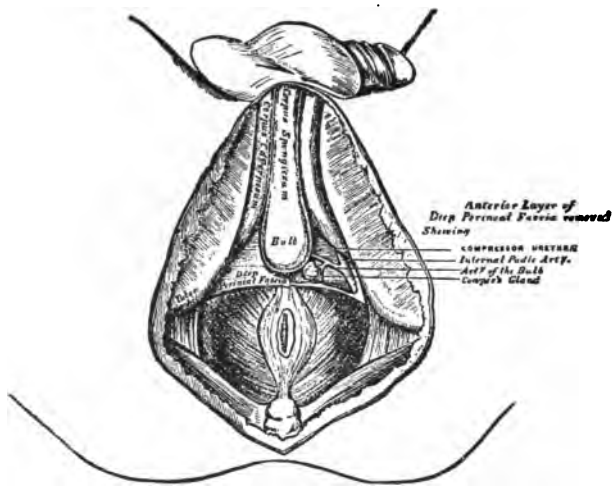

FIG. 169.

Male perineum, superficial dissection. (*Lydston.*)

It *contains*:—
The internal pudic artery, nerve, and veins;
The inferior hæmorrhoidal vessels and nerves;
The perineal and fourth sacral nerves; and
A mass of areolar tissue.

PERINEUM.

The perineum is the triangular space between the anus and scrotum in the male, and between the anus and vulva in the female. The skin is dark, thin, and supplied with sebaceous and sudoriparous glands, and is marked by middle line or *raphé*.

Fasciæ of the Perineum.

The *pelvic fascia* at the brim of the pelvis is continuous with transverse and iliac fascia; covers sacrum and pyriformis muscle, external iliac artery, and sacral nerves. It forms the anterior and lateral ligament of bladder (true). It forms arcus tendinæ, or white line, corresponding to division of pelvic fascia into two layers, the obturator and recto-vesical, extending from pubis to spine of ischium, from which originates the levator ani muscle, with recto-vesical and ischio-rectal or anal fasciæ above and below the muscle respectively.

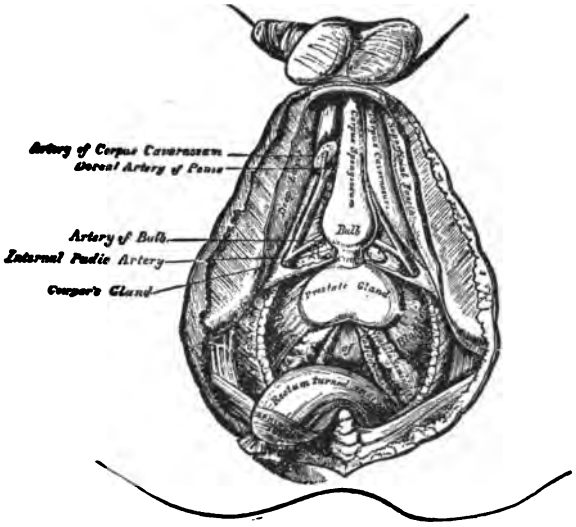

FIG. 170.

Male perineum, deep dissection. (*Lydston.*)

The *obturator fascia,* the continuation of the pelvic fascia, incloses the pudic vessels and nerve in a sheath, covers the internal obturator muscle, and forms the posterior layer of the triangular ligament.

Recto-vesical or *visceral layer* of the *pelvic fascia,* the continuation of the pelvic fascia, descends into the pelvis investing the prostate gland and the vesico-prostatic plexus of veins, the bladder (forming the anterior and lateral true ligaments) and the rectum. It is perforated in the female by the vagina.

Superficial perineal fascia consists of superficial fat layer and deep membranous layer. The former is continuous with subcutaneous layer of buttocks, thigh, and labia, and posterior to anus become continuous with tissue of ischio-rectal fossa. The *superior layer* passes from rami of pubis and ischium to the tuberosity of ischia, covering ischio-cavernous and bulbo-urethral muscles, and becomes continuous with the deep perineal fascia.

The *deep perineal fascia* (triangular ligament) is a strong triangular membrane extending between the rami ischii et pubis, its apex attached to the under surface of the symphysis. It is often described as consisting of two layers, the anterior and posterior (superior and inferior). It is pierced by the membranous urethra, and sends a fascia surrounding the urethral glands to the spongy body. In the female it is weaker, the urethra also pierces it, and it is continuous with the fascia of the vagina.

Muscles of the Perineum.

ISCHIO-CAVERNOUS (erector penis) arises in the inner surface of the tuberosity of the ischium, and is inserted into the side and under surface of the crus penis. In the female there is a similar insertion into the clitoris. It serves to maintain the organ erect. *Nerve,* perineal.

BULBO-CAVERNOUS (accelerator urinæ, ejaculator seminis) arises from central tendon of perineum and from median *raphé* in front. It spreads out and is inserted from behind forward to anterior surface of triangular ligament, bulb and adjacent part of corpus spongiosum, to join fibres of opposite side, and to sides of corpora cavernosa; anterior to erector penis and in fibrous expansion over dorsal blood-vessels of penis.

It accelerates the flow of urine and semen and contributes to erection of the penis. *Nerve,* perineal.

VAGINAL CONSTRICTOR (sphincter vaginæ), analogous to foregoing muscle, surrounds the orifice of vagina. It arises from the central tendon and passes forward on either side of vagina to be inserted into the corpora cavernosa and body of clitoris. It compresses the dorsal vein of the clitoris.

ERECTOR CLITORIDIS corresponds to erector penis muscle in the male, but smaller.

TRANSVERSE PERINEAL arises from inner part of ramus of ischium, and is inserted into perineal centre in male, into the side of sphincter vaginæ in the female. It steadies the perineal centre. *Nerve,* perineal.

DEPRESSOR URETHRA, or Jarjavay's muscle, arises from the rami ischii, and joins the constrictor and its fellow of the opposite side over the urethra. *Nerve,* perineal.

EXTERNAL SPHINCTER ANI muscle arises from the apex of the coccyx and the superficial fascia, and is inserted into the perineal centre, blending with the levator ani, accelerator urinæ, and transversus perinei. It closes the anus. *Nerve,* fourth sacral.

INTERNAL SPHINCTER ANI is an aggregation of circular fibres of the intestine, forming a muscular ring one inch in breadth, surrounding the lower portion of the rectum.

SPHINCTER TERTIUS is a ring of fibres described by Hertyl and others, arising from the sacrum and surrounding the rectum about four inches above the anus.

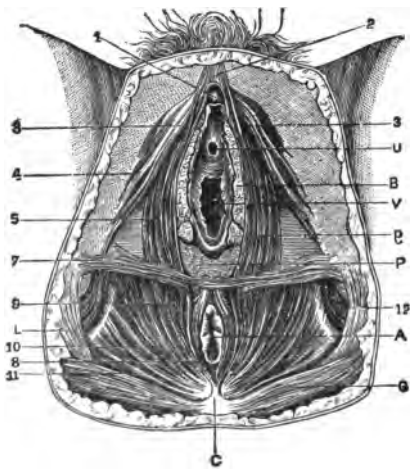

FIG. 171.

Female perineum: A, anus; B, bulbo-vaginal; C, coccyx; G, gluteus maximus; P, perineal body; U, urethra; V, vagina; G, vulvo-vaginal gland; 1, clitoris; 2, its suspensory ligament; 3, crura clitoridis; 4, erector clitoridis; 5, bulbo-cavernosus; 7, transversus perinæi; 8, sphincter ani; 9 and 10, levator ani; 11, coccygeus; 12, obturator externus.

ANAL ELEVATOR (levator ani) arises in front from body and ramus of pubis and symphysis, posteriorly from spine of ischium, and on either side from angle of arcus tendinæ (white line). It is inserted by posterior fibres into coccyx, and anterior fibres into the muscle of opposite side in a median *raphé* extending from coccyx to anus; middle fibres into rectum, joining with sphincter; anterior to prostate, blending with external sphincter and transverse fascia. In the female it is inserted into the vagina instead of the prostate.

It helps with its fellow to form the floor of the pelvis, and supports the vagina, rectum, and pelvic viscera. *Nerves,* inferior hæmorrhoidal and fourth sacral.

COCCYGEUS MUSCLE (coccygei), from the spine of the ischium and lesser sacro-sciatic ligament, and is inserted into the margin of coccyx and side of lowest segment of sacrum. It raises the coccyx and forms the posterior part of the pelvic floor. *Nerve,* anterior division of the fifth sacral.

The muscles of the female perineum are:—

Superficial Set.

Sphincter vaginæ, or bulbo-cavernosus;
Erector clitoridis;
Transversus perinæi;
Sphincter ani;
Levator ani;
Coccygeus.

Deep Set.

Transversus perinæi (deep);
Constrictor vaginæ;
Depressor urethræ, or Jarjavay's muscle.

The structures beneath the deep layer of the superficial fascia are:—

Erector penis muscle;
Accelerator urinæ muscle;
Transversus perinæi muscle and arteries;
Superficial perineal vessels.

The structures between the two layers of the deep perineal fascia are:—

Compressor urethræ muscle;
Membranous urethra;
Subpubic ligament;
Dorsal vein of penis;
Pudic vessels and nerves;
Venous plexus;
Cowper's glands and ducts;
Arteries and nerves of bulb.

ANATOMY OF LATERAL LITHOTOMY.

The incision is made through a triangular interval formed by the transversus perinæi, accelerator urinæ, and erector penis muscles, and divides the following structures in the order named:—

Skin and superficial fascia;

Inferior hæmorrhoidal vessels and nerves;
Accelerator urinæ muscle;
Superficial perineal vessels and nerve (sometimes);
Deep perineal fascia;
Anterior part of levator ani;
Part of compressor urethræ;
Membranous and prostatic positions of urethra;
Left lobe of prostate gland.
The structures to be avoided are:—
In median line, rectum and bulb of corpus spongiosum;
Externally, internal pudic artery;
Forward, artery of the bulb;
Backward, posterior part of prostatic gland and neck of the bladder.

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