Medical Epitome Series

ANATOMY

LITTLE

(The Medical Epitome Series)

ANATOMY

A MANUAL FOR STUDENTS AND PRACTITIONERS

BY

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PHILADELPHIA

THIRD EDITION, REVISED AND ENLARGED

INCLUDING

SELECTED LIST OF STATE BOARD EXAMINATION QUESTIONS

ILLUSTRATED WITH SEVENTY-FIVE ENGRAVINGS

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PREFACE

This book is intended to present in a clear and concise manner more than the mere essentials of human anatomy. To accomplish this some of the less important points have yielded space to those of more practical bearing. Embryology, histology, and applied anatomy have not been considered as coming within its scope.

It is interesting to note the history of this little work. The original issue was published from the manuscript of Dr. F. J. Brockway, whose untimely death was a great loss to all true students of anatomy. The value of his work was so widely appreciated that it ran through several printings, and in response to the continued demand it was revised with additions, and rearranged with questions grouped at the end of the sections, by Dr. Henry E. Hale, then Demonstrator of Anatomy at the College of Physicians and Surgeons, New York. His edition was likewise widely approved, as indicated by the call for successive printings. Meanwhile he became identified with other subjects, and this new and revised issue is accordingly executed by other hands. It is hoped that so brought to date the little work will continue to enjoy its merited popularity. Perhaps the most important of the changes is that relating to the cerebrospinal axis, which is described with sufficient detail of the most important masses entering into its intricate formation to enable the reader to grasp its structures with facility. In addition to the questions following each section a selected list of State Board Examination Questions has been inserted immediately preceding the index, a feature which should prove of service to the student preparing himself in the subject.

I wish to thank my friend and colleague, Professor E. A. Spitzka, of the Jefferson Medical College, for his encouragement and valuable suggestions, particularly in regard to the nerve system.

J. F. L.

PREFACE TO SECOND EDITION

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PHILADELPHIA, 1911.

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ANATOMY

PART I

OSTEOLOGY, OR THE ANATOMY OF THE OSSEOUS SYSTEM

THE CLASSIFICATION AND STRUCTURE OF BONES

Anatomical Position.—The **skeleton** is the solid framework of the body, composed of bones with the intervals completed by cartilage. The number of bones in the human adult skeleton is 206, thus classified:

Axial skeleton	Vertebral column	26	
	Skull	22	
	Hyoid bone	1	
	Ribs and sternum	25	
		—	74
Appendicular skeleton	Upper limbs	64	
	Lower limbs	62	
		—	126
Auditory ossicles			6
Total			206

The patella and pisiform are included, but *not* the small sesamoid bones. The teeth belong to the epidermal layer.

Bones are **formed by ossification** in two ways—**intracartilaginous** and **intramembranous**.

The vertex of the skull—*i. e.*, the parietals, the frontal, the tabular part of the occipital, the squamous, and tympanic parts of the temporal, the inner plate of the pterygoid process, the bones of the face except the inferior turbinate and part of the lower jaw—are formed in membrane. The base of the skull and all other bones are formed in cartilage. A deposit of bone begins at one spot, the *primary centre;* the shaft, or diaphysis, is formed from this. Most bones have *secondary* or *tertiary* centres of ossification, and parts derived from them are the *epiphyses* (*growths upon*). The growth of bone in length depends upon the cartilage between the epiphyses and diaphysis; this cartilage acts as a buffer. Growth in circumference is subperiosteal.

All bones are covered with a vascular, connective-tissue membrane, called *periosteum.*

For the sake of description, bones are divided into four classes: (1) *Long,* (2) *short,* (3) *flat,* and (4) *irregular bones.*

Long bones present a shaft and two extremities. The *shaft* is hollow and more or less cylindrical. The walls are made of *dense bone,* thickest near the middle, and decreasing in thickness toward the ends. The hollow in the centre is the *medullary canal,* and is lined with *internal periosteum* or *medullary membrane,* and contains *marrow* in the recent state, The *extremities* are expanded portions, made up of *spongy bone,* closed in by a thin layer of *compact bone.* The interstices of the spongy bone also contain marrow. Examples, femora and humeri.

Short bones are small, made up of spongy bone, with a compact bony shell. Examples, carpals and tarsals.

Flat bones have two compact plates enclosing a spongy layer, the *diploë.*

Irregular bones are such as cannot be classed with either of the other groups. They are mostly situated symmetrically across the median plane of the body. Their composition is a compact shell enclosing spongy bone, which makes up the great bulk of these bones. Examples, vertebræ, sphenoids, malars, etc.

Medullary Arteries.—The medullary arteries of the large, long bones of the extremities run *from the knee* and *toward* *the elbow.* This may be remembered by flexing the knees and elbows, and noting that the medullary arteries run *down as though impelled by gravity.*

THE BONES OF THE TRUNK

The parts of the trunk are the vertebral column, the sternum and ribs, the hyoid, and bones of the skull.

The clavicle and scapula do not belong to the trunk; they form the shoulder girdle.

The os innominatum goes to form the pelvic girdle, completed behind by the sacrum, which belongs to the trunk.

THE VERTEBRAL COLUMN

The *vertebral column* is composed of a series of vertebræ (*verto,* to turn), originally thirty-three in number. The upper twenty-four remain separate as movable or true vertebræ; these are succeeded by five united into the *sacrum;* then follow four dwindled segments united into the coccyx. These lower nine are the fixed or false vertebræ.

Beginning at the skull, there are seven cervical, twelve dorsal or thoracic connected with ribs, five abdominal or lumbar, five sacral, and four coccygeal vertebræ. The number in the cervical region is constant; those between the dorsal and lumbar may vary reciprocally. If there are but eleven pairs of ribs, the twelfth dorsal vertebra will have lumbar characteristics; if thirteen pairs, the first lumbar will have dorsal characteristics. A transitional *lumbosacral vertebra* is met with, one side connected with the sacrum, the other having a free transverse process.

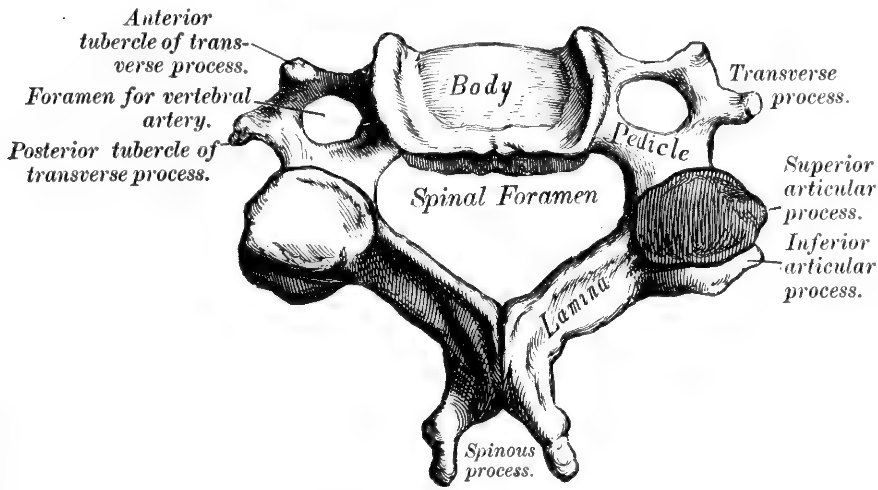
Characteristics of Vertebræ.—The first two cervical vertebræ are called *rotation* vertebræ; all the other true ones, *flexion* vertebræ. A representative vertebra, like the tenth dorsal, presents a body for the purpose of support, an arch and spinal foramen for protection, and seven processes for leverage. The *body* or *centrum* is a short cylinder; the superior and inferior surfaces are flat, with a rim around the circumference. The front and sides are convex horizontally and concave from above down. The posterior surface is slightly concave from side to side, and marked by one or two venous foramina. The *neural arch* consists of two symmetrical portions meeting in the median plane behind. The anterior part or pedicle rises from a point on the body where the lateral and posterior surfaces meet; the posterior part or *lamina* is broad and flat. The upper and lower borders of pedicles form *vertebral* notches, becoming *intervertebral foramina* between contiguous vertebræ. The *spinous process* projects back from the junction of the two laminæ. The *transverse processes,* one on either side, project outward from the arch at the junction of the pedicle with the lamina. The *articular processes,* two superior and two inferior, project upward and downward at the point of origin of the transverse processes.

The *foramen* is bounded anteriorly by the body, posteriorly and laterally by the arch; the series of rings thus formed constitutes the spinal canal.

The Cervical Vertebræ

The *body* is smaller than those of any other region; it is broad transversely; the upper surface is concave because of the upward projection of lateral lips, and is sloped down in the front. The under surface is rounded at the sides and lipped anteriorly, so there is interlocking at the sides to prevent lateral displacement—an anterior lip to prevent posterior, and articular processes to prevent anterior, dislocations. The *laminæ* are long and flat, overlapping those of the vertebra next below. The *superior* and *inferior notches* are nearly equal in depth. The *spinous processes* are short and bifid, increasing in length from the fourth to the seventh inclusive. The *transverse processes* are directed outward, downward, and forward, and present at their extremities an anterior and a posterior tubercle. Each process is grooved above, and perforated vertically at its base by the *vertebrarterial foramen* for a vein, artery, and plexus of nerves. This foramen is between the two roots of the process, the posterior corresponding to a dorsal transverse process, and the anterior to a rib. It is characteristic of this region. The *articular processes* are placed at the extremities of a short vertical column of bone; the *superior articular surface* is oval and looks up and back; the *inferior* down and forward. The foramen is triangular, and larger than in any other region. The *peculiar cervical vertebræ* are the first, second, and seventh.

FIG. 1



A cervical vertebra. (Gray.)

The Rotation Vertebræ

THE ATLAS

The *atlas* (supporting globe of head) has no body or spinous process, but is a large ring with articular and transverse processes. The posterior part of the ring corresponds to the neural canal of the other vertebræ; the anterior part is occupied by the odontoid process of the axis. The anterior boundary of the ring is the *anterior arch*, with a small tubercle in front for the longus colli muscle. Behind the tubercle is an articular surface for the odontoid process. At the sides of the ring are the lateral masses bearing the superior and inferior articular processes. All the articular processes of the atlas and the superior ones of the axis are in front of the vertebral notches. The *superior articular* surfaces of the atlas are oval and converge in front. They look upward and inward and a little backward, and form a cup for the occipital condyles. These may be partially subdivided by a transverse groove, and below the inner margin of each is a tubercle for the transverse ligament. The *inferior articular* surfaces are slightly convex, nearly circular, and do not wholly cover or fit the superior processes of the axis. The *posterior arch* presents in the median line either a ridge, hollow, or small tubercle. If a *spinous* process were well developed here, nodding of the head would be prevented. Just behind the lateral mass is a smooth sinus, the vertebral notch. The *transverse* processes are not bifid—are large and strong for attachment of rotatory muscles.

Varieties.—The posterior or anterior bony arch may be incomplete; the anterior root of the transverse process may be ligamentous. A spicule of bone may bridge over the superior vertebral notch, and the canal formed be subdivided by other spicules. The artery and vein go through the upper subdivision, the suboccipital nerve through the lower.

The Axis (Epistropheus)

The second vertebra forms an axis upon which the atlas carrying the head rotates. The body of the atlas is joined upon that of the axis in the form of a tooth-like process, the odontoid. Its apex is pointed, and just below is an enlargement or head, both giving attachment to bands of the check ligament.

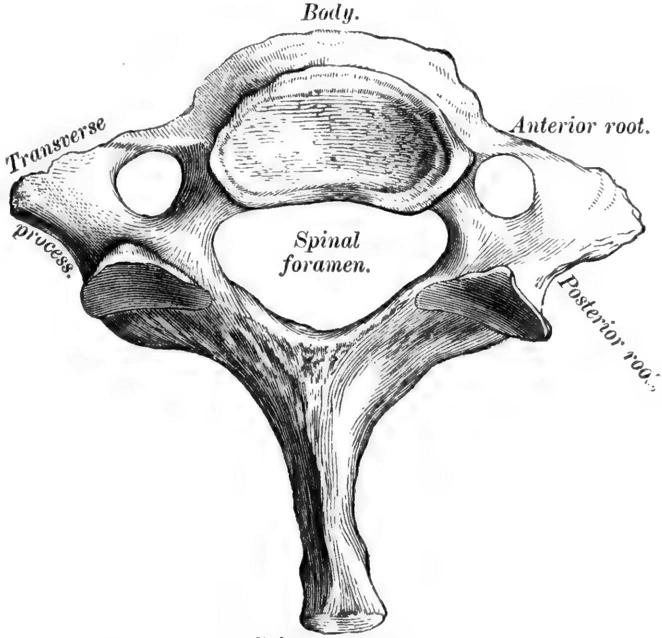
The process has in front a smooth articular surface for the arch of the atlas, and behind a smooth groove for the transverse ligament. This makes a slight constriction, but hardly a neck.

The anterior surface of the body presents a slight ridge separating two depressions. The superior articular surface lies close to the odontoid process, upon the body in part and upon the pedicles; they look up and out. The inferior articular surfaces are behind the upper, and resemble corresponding ones in the cervical region. The spinous process is grooved inferiorly—is very large and bifid, in contradistinction to that of the atlas. The transverse processes are short, with the anterior tubercle nearly suppressed. The inferior vertebral notch is in front of the articular surface, which is the rule for both notches below this in the column.

The Seventh Cervical Vertebra (Vertebra Prominens)

This has a long spinous process, non-bifurcated, nearly horizontal, and projecting under the skin; hence the name *vertebra prominens.* Attached to it is the lower end of the ligamentum nuchæ. The transverse processes are massive, slightly grooved, with a small foramen or none at all; the posterior tubercle is large and the anterior one very small.

Fig. 2



Seventh cervical vertebra, or vertebra prominens.

The vertebral artery and vein do not pass through these foramina, but in front of them; both veins may, sometimes the left artery does; the vessels may enter no foramina until the fourth vertebra is reached.

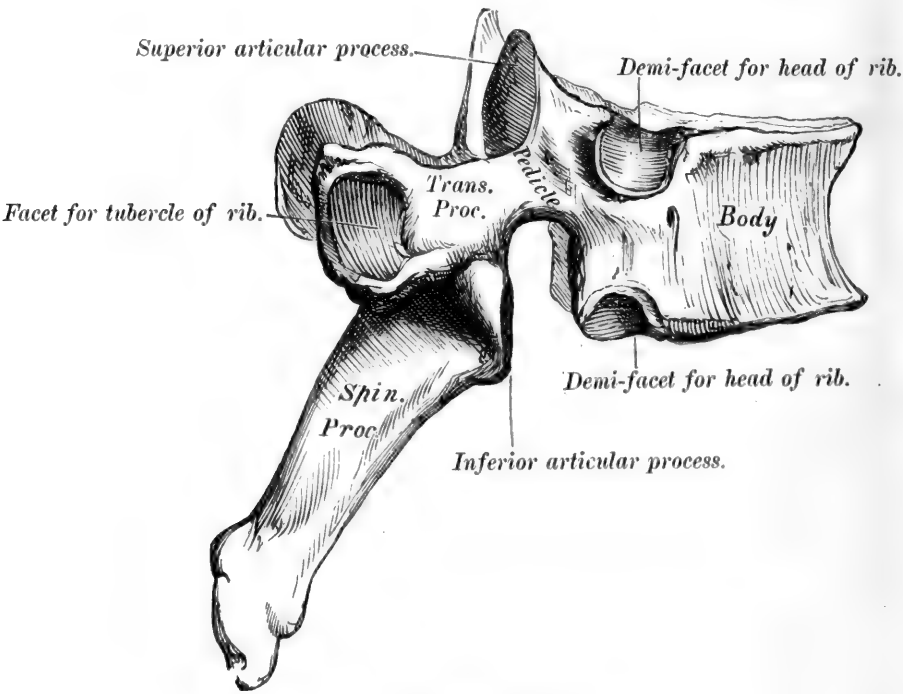
Varieties.—The anterior tubercle of the sixth is large, and is called *Chassaignac's* and *carotid tubercle.* The common carotid artery may be compressed against it; opposite this level the omohyoid crosses beneath the sternomastoid muscle;

the inferior thyroid artery crosses beneath the common carotid. Opposite it, also, are the cricoid cartilage, the lower ends of the larynx and pharynx, and the beginning of the trachea and esophagus.

The Dorsal or Thoracic Vertebræ

The dorsal vertebræ are intermediate in size between the cervical and lumbar, increasing in size from above downward. They are easily recognized by the articular facets for the ribs.

FIG. 3



A dorsal vertebra.

The *body* is relatively small, and heart-shaped; its antero-posterior and transverse diameters are nearly equal, and its depth is greater behind than in front. Where the arch joins the body there are articular surfaces for the heads of ribs, generally two on each side, one at the upper and one at the lower border; these, when the vertebræ are articulated, form with the facet on the intervertebral fibrocartilage a complete facet for the head of a rib.

Between the neck of a rib and the transverse process articulating with it is the costotransverse foramen. In the cervical region this is represented by the vertebral foramen, and in the lumbar region the space is filled by the bony mass of the transverse process.

The *laminæ* are broad and flat, and overlap each other. The spinal foramen is circular and smaller than in other regions. The *pedicles* are directed backward from the upper part of the body. The inferior intervertebral notches are deeper than in any other region of the spine.

The *superior vertebral notches* are shallow or absent.

The *spinous processes* are bayonet-shaped, and terminate in a slight *tubercle.* They are longest and most oblique, sloping downward and back progressively, from the fifth to the eighth.

The *transverse processes* are situated behind the articular processes and pedicles, and are directed outward and backward, and terminate in a clubbed extremity, which presents anteriorly a small concave articular surface, for the tuberosity of a rib, and also three indistinct *tubercles,* one from the upper border, one from the lower, and the third externally, for muscular attachments. The *articular processes* are nearly vertical, with smooth flat surfaces. The *superior* look back, a little outward and up. The *inferior* look in the reverse direction.

The Atypical Dorsal Vertebræ

The first, ninth, tenth, eleventh, and twelfth are to be distinguished. The **first dorsal** resembles the seventh cervical. Its body above is transversely concave and lipped. The superior vertebral notches are deep, the superior articular processes are oblique, and the spinous process is nearly horizontal. On the side of the body, close to the upper border, are a whole facet for the first rib and a very small demifacet below for the second rib.

The **twelve ribs** correspond to twelve joint surfaces, but these are divided, so that only the *first, tenth, eleventh,* and *twelfth* present single facets; the first in addition has a half-facet, and the *ninth* has one demifacet above and none below.

In some cases the ninth vertebra has two demifacets on each side; in these instances the tenth has a demifacet above and none below.

The **tenth dorsal** touches only one rib on a side, and has a complete facet, mostly on the pedicle at its upper border. The transverse process has a small facet.

The **eleventh dorsal** has one complete facet on each side, but none on the transverse process.

The **twelfth dorsal** has a single facet on each side. It strongly resembles a lumbar vertebra.

The inferior articular surfaces turn out. The spinous process is short and nearly horizontal.

The transverse processes are short, and present near their extremities the *external, superior,* and *inferior tubercles,* which correspond respectively to the *transverse, mammillary,* and *accessory processes* of the lumbar vertebræ. Rudiments of these tubercles may be sometimes seen on the other dorsal vertebræ. The row of costal facets forms the anterior border of the intervertebral foramina. The ribs in moving intrude somewhat upon the vessels and nerves in those foramina; hence the "floating," most movable, ribs articulate with single vertebræ.

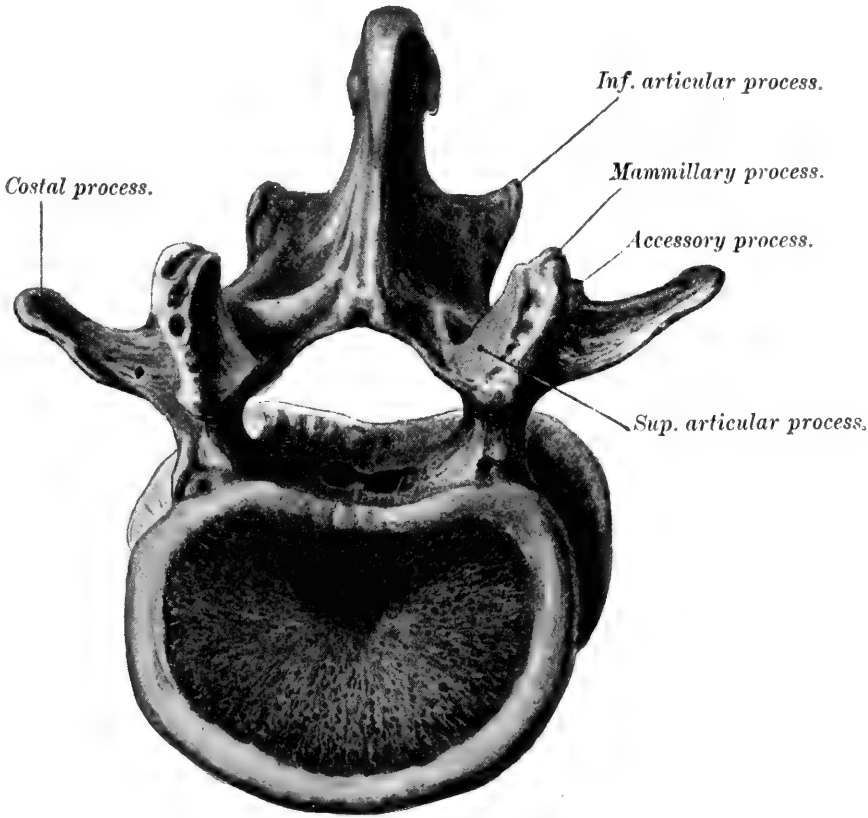
The Lumbar Vertebræ

These are the largest of the movable vertebræ. They may be distinguished by the absence of costal articular surfaces and the absence of foramina through the transverse processes. The *body* is reniform, broad transversely, deeper in front than behind, and markedly constricted at the sides. The *pedicles* are very thick, directed backward from the upper part of the bodies. The *laminæ* are short and thick, the superior notches shallow. The spinous processes are horizontal, and broad and thickened at their extremities. The spinal foramen is triangular, larger than in the dorsal region, but smaller than that in the cervical.

The *transverse processes* are slender and project directly out; they are in front of the articular processes, and are considered to be homologous with the ribs. Their extremities lie in series with the external tubercles of the lower dorsal transverse processes. The *accessory process* (*anapophysis*) lies behind each lumbar transverse process at its base, and points down. It is large in some animals, and locks the vertebræ together.

The *articular processes* present vertical articular surfaces, the *superior* concave looking in and back, the superior are farther apart than the inferior, and embrace an inferior pair above them. The *inferior* are convex and look outward and forward.

Fig. 4



A lumbar vertebra. (Gray.)

The *mammillary process* (*metapophysis*) projects back from each superior articular process.

The *fifth* lumbar is massive, the inferior articular processes wider apart than the upper; the transverse processes are broad and conical, and the laminæ project into the spinal foramen.

The Sacrum and the Coccyx

The *sacrum* and the *coccyx* are the result of the fusing of the lower *nine* vertebræ into two bones, *five* to make up the sacrum, and *four* (occasionally *five*) the coccyx.

The **sacrum** is pyramidal, much larger than the coccyx; situated between the iliac bones, articulating above with the fifth lumbar vertebra, below with the coccyx. It is much curved on itself, with the concavity in front. It presents an anterior or ventral and a posterior or dorsal surface, two lateral masses, a base, an apex, and a central canal for description.

The *anterior* or *ventral surface* looks considerably downward, forming a projection with the last lumbar, the *sacrovertebral angle* (about 120 degrees). This surface is concave from above down and less so from side to side, and is crossed by four horizontal ridges, indicating the union of five vertebræ. At the ends of the ridges are four *anterior sacral foramina,* which lead externally into grooves on the lateral masses.

The two rows of *foramina* are approximately vertical, only approaching the median line slightly below, as the widths of the bodies are equal. They are directed forward and slightly outward, and diminish in size from above downward. The anterior branches of the sacral nerves pass through them.

The *posterior* or *dorsal surface* looks up and back, is convex and rough, and along the median line are three or four small spinous processes, more or less connected, forming a ridge; the upper is prominent and usually quite distinct from the others. Below the ridge is an inverted V- or U-shaped opening into the central canal. It is bounded by the imperfect laminæ of the fourth and fifth sacral, and by the inferior articular processes of the last sacral, which are prolonged down into the *sacral cornua* to meet corresponding ones from the coccyx. On each side of the median ridge the united laminæ are hollowed into the *sacral groove,* a continuation of the vertebral groove above, giving origin to a part of the erector spinæ; next externally is a row of tubercles representing articular and mammillary processes; next the four *posterior sacral foramina,* opposite to, but smaller than, the anterior. They transmit the posterior branches of the sacral nerves and correspond to the spaces between the transverse processes—the anterior to the spaces between two ribs.

The *lateral mass* is that part external to the foramina, broad above and narrow below. It is made up of broadened transverse processes, rudiments of which are seen outside the posterior sacral foramina; the first pair are large, the second are smaller, on each side these two and the upper half of the third, by an uneven auricular lateral surface, enter into the formation of the sacroiliac joint; the fourth and fifth give attachment to portions of the gluteus maximus, and the greater and lesser sacrosciatic ligaments. Anteriorly are four *shallow grooves,* separated by ridges which give attachment to the pyriformis muscle. Behind the auricular surface it is very rough for the attachment of the posterior sacroiliac ligament. Lower down the bone terminates in the *inferior lateral angle,* below which is a half-notch, forming a foramen with the coccyx for the fifth sacral nerve.

The *base* shows the reniform first sacral body, behind which is the triangular aperture of the sacral canal; on each side of this is a large articular process similar to the superior ones of the lumbar vertebræ, bearing a large mammillary process. In front of this is a vertebral groove which helps form the last lumbar intervertebral foramen. Externally is a modified transverse process, and in front of that a smooth triangular surface continuous with the iliac fossa, the *ala* of the sacrum.

The *apex* is the body of the fifth sacral vertebra, transversely oval; it articulates with the coccyx. The *sacral canal* curves with the bone, and becomes smaller as it descends. A transverse section is triangular above, but flattened below, its posterior wall, however, being still arched. From it there pass out four pairs of intervertebral foramina, opening anteriorly and posteriorly into the anterior and posterior sacral foramina, and closed externally by the lateral masses.

Differences in the Sacrum of the Male and Female.—In the female it is wider, is less curved, the upper half nearly straight, is more obliquely placed, and forms a more marked promontory than in the male.

The **coccyx** is pyramidal. Its vertebræ are very rudimentary, *four* in number (rarely *five* or *three*). Of the first one, the pedicles and superior articular cornua project upward, and help form the last intervertebral foramen. The short transverse process usually bounds a notch for the anterior division of the fifth sacral nerve; or if it touches the inferior lateral angle of the sacrum, it forms a fifth anterior sacral foramen. The second vertebra has rudiments of transverse processes, and two small eminences in line with the cornua, representing the last traces of a neural arch. The third and fourth are mere nodules, and represent vertebral bodies only. In adult life the first piece is often separate, and the other three united. All four may form one bone, which occurs oftener and earlier in the male.

To the edges of the coccyx are attached, *in front,* the coccygeus muscle; *behind,* the gluteus maximus; and *between these* the sacrosciatic ligaments. *To the apex* is attached the external anal sphincter.

This bone may consist of *five* vertebræ, or more rarely of only *three.*

The Vertebral Column as a Whole

It is a central axis upon which other parts are arranged, situated in the median line at the posterior part of the trunk; above, it supports the head, laterally the ribs, and it rests on the hip bones below. Its average length measured along the curves is 28 inches in the male and 27 inches in the female; persons seated in a row appear of about the same height.

Viewed from the front, the column is formed of two pyramids applied base to base at the junction of the last lumbar with the sacrum.

All three diameters of the vertebræ increase from the third cervical to the last lumbar; vertical diameter, from $\frac{3}{5}$ to $1\frac{1}{5}$ inches (14 mm. to 29 mm.); sagittal, from $\frac{3}{5}$ to $1\frac{2}{5}$ inches (14 mm. to 35 mm.); transverse (does not increase in dorsal region), from $\frac{4}{5}$ to $2\frac{1}{5}$ inches (21 mm. to 55 mm.).

The column presents a slight lateral curve, convex to the right in *right-handed* persons, convex to the left in *left-handed* persons (Bichat).

Viewed laterally there are four curves, alternately convex and concave; the cervical, dorsal, lumbar, and pelvic; the cervical extends from the odontoid to the second dorsal; the dorsal is concave forward and ends at the twelfth dorsal; the lumbar ends at the sacrovertebral angle, and the pelvic ends at the tip of the coccyx. The dorsal and pelvic curves are primary, exist at birth, enter into the formation of bone-walled cavities, and are due to the conformation of the vertebral bodies. The cervical and lumbar curves are secondary, and are formed after birth. They are mainly due to a change in shape of the intervertebral disks.

Posteriorly, the *spines* occupy the median line or may be normally twisted a little from it. In the cervical region they are short and bifid, sloping backward and a little downward; in the dorsal they are oblique above, more oblique in the mid-portion, and nearly horizontal below; in the lumbar they are horizontal. A cross-section of a cervical spine is semilunar; of a dorsal, triangular; of a lumbar, oblong. On either side of the spines is the vertebral groove, bounded externally in the cervical and dorsal region by the transverse processes, and in the lumbar by the mammillary processes. The *transverse processes* of the atlas are long; of the axis, short, increasing to the first dorsal, thence diminishing to the last dorsal, and becoming suddenly much longer in the lumbar vertebræ. In the cervical region the transverse processes are in front of the articular processes and between the intervertebral foramina. In the dorsal region they are behind both. In the lumbar region they are in front of the articular processes and behind the intervertebral foramina.

The *intervertebral foramina* are always in front of the articular processes, except those of the atlas and the upper ones of the axis. They are named from the upper of the two vertebræ which go to form them, excepting in the cervical region, where there are eight, the fissure between the skull and atlas being called the first.

The *spinal canal* has three sets of openings into it, the two rows of the intervertebral foramina and the intervertebral fissures between the lamina. It is narrowest in those parts having least motion, viz., in the dorsal and sacral regions. It is round and $\frac{3}{5}$ of an inch (17 mm.) in diameter in the dorsal region; it is triangular, with the apex behind, in the cervical and lumbar regions; and largest of all in the cervical regions.

The Hyoid Bone

The **hyoid,** or **os linguæ,** is situated at the base of the tongue opposite the second or third cervical vertebra, and is shaped like the Greek letter *upsilon.*

It is made up of five portions, a body, two greater and two lesser cornua.

The *body* is prismatic, presenting three roughly quadrilateral surfaces and five borders. It is compressed obliquely from above downward and backward.

The *superior surface* looks upward and a little forward, and is separated by a horizontal border or ridge, with a tubercle in the centre, from the anterior surface. There are depressions above and below this border, on either side of the median line, for muscular attachment of the geniohyoid over the greater part of the anterior surface and adjoining part of the superior. On the superior surface behind this is the geniohyoglossus and chondroglossus. On the anterior surface from within out, the mylohyoid, stylohyoid, and aponeurosis of the digastric, and between two angular processes of the geniohyoid externally, a part of the hyoglossus.

The *posterior surface* is concave and faces the epiglottis, from which it is separated by loose areolar tissue and the thyrohyoid membrane.

The borders are anterior, posterior, and inferior.

The *anterior border* is rounded and separates the anterior and superior surfaces. The attachment of the geniohyoid extends over much of it.

The *posterior border* is well marked and gives attachment to the thyrohyoid membrane.

The *inferior border* has attached in front the sternohyoid, and laterally the omohyoid and a part of the thyrohyoid.

The *lateral borders* are small and oval for articulation with the greater cornua.

The *great cornua* project backward, and are flattened obliquely from above downward, terminating posteriorly in a *tubercle* for attachment of the lateral thyrohyoid ligament.

The *anteroexternal surface* has attached a portion of the hyoglossus, and to the upper border the middle constrictor of the pharynx, and their *lower borders* a portion of the thyrohyoid muscle. After middle life they have bony union with the body.

The *small cornua* are short and conical, and project up and back from the junctions of the great cornua and body; they give attachment to the stylohyoid ligaments and have synovial articulations with the body.

THE BONES OF THE HEAD

The skull is divided into two parts, the *cranium* and *face;* the former protects the brain; the face surrounds the mouth, nasal cavities, and orbits in part. There are twenty-two bones forming the skull as a whole.

The cranium has eight bones.

(*a*) Unpaired:
- Occipital.
- Sphenoid.
- Ethmoid.
- Frontal.

(*b*) Paired:
- Temporal.
- Parietal.

The face has fourteen bones.

(*a*) Unpaired:
- Vomer.
- Mandible.

(*b*) Paired:
- Nasals.
- Maxillæ.
- Lacrymals.
- Malars.
- Palates.
- Turbinates.

THE BONES OF THE CRANIUM

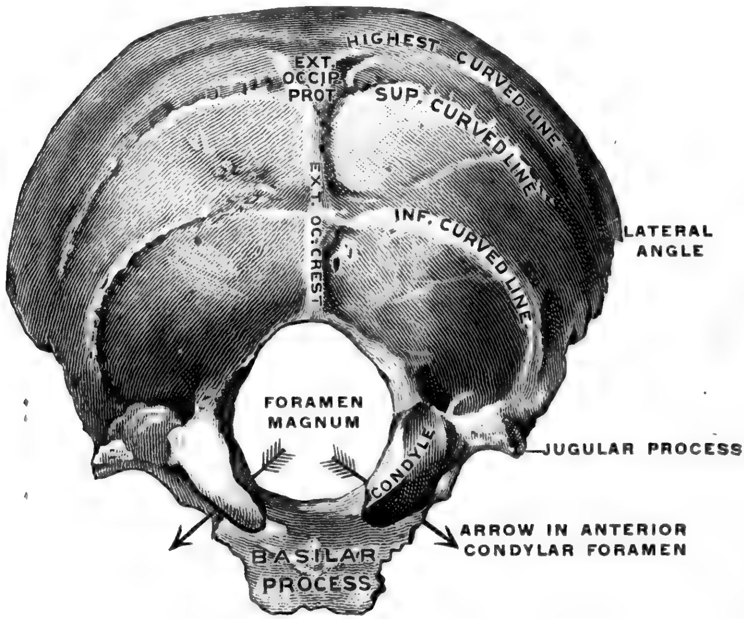
The Occipital Bone

The occipital bone, situated in the back part and base of the skull, is flattened, lozenge-shaped, and bent on itself, presenting two surfaces, four borders, and four angles. The *internal* or *cerebral surface* is concave; the *posterior* or *external* is convex. It *articulates* with six bones—two parietal, two temporal, the sphenoid, and atlas.

Below and in front the bone is pierced by the foramen magnum, a large oval opening with its long axis anteroposteriorly placed (*foramen occipitale*), for the passage of the spinal cord and membranes, spinal portions of the spinal accessory nerves, and two vertebral arteries. The part behind the foramen is the *tabular portion,* in front is the *basilar portion,* at the sides are the *condylar portions.*

The *tabular portion* presents posteriorly near the centre the *external occipital protuberance*, from which the *superior curved line* arches outward on each side to the lateral angles; a little above this may usually be seen the *highest* or *supreme curved line*. Below the protuberance is a median *external occipital crest*, from the centre of which passes out the *inferior curved line* to the jugular processes.

FIG. 5



The occipital bone, viewed from below. (Spalteholz.)

To the supreme curved line is the bony attachment of the epicranial aponeurosis; to the superior curved line, most internally, the biventer cervicis, for the inner third the trapezius, next the occipitalis, sternocleidomastoid, and splenius capitis. Between the superior and inferior lines are, internally a large impression for the complexus, and externally a small one for the superior oblique. Below the lower line is an inner impression for the rectus capitis posticus minor, and an outer one for the major. The ligamentum nuchæ is attached to the protuberance and crest.

The *internal surface* of the tabular portion shows two ridges crossing each other, one from the upper angle to the foramen magnum, one connecting the two lateral angles. Where these intersect is the *internal occipital protuberance,* not always opposite the external. The ridges mark off four hollows, the *superior* and *inferior occipital fossæ,* which lodge the posterior cerebral and the cerebellar lobes. The ridges are grooved for venous sinuses. The space where the longitudinal sinus is continued into a lateral one, generally the right, lodges the *torcular Herophili* (wine-press of Herophilus). Below this the vertical ridge is sharp, and named the *internal occipital crest.*

The *condylar portions* bear the articular surfaces for the atlas; these condyles converge toward the front, are doubly convex, and somewhat everted. At the inner side of each is a rough impression for a lateral odontoid ligament. Perforating the condyle from within out is the *anterior condylar foramen* for the hypoglossal nerve and a branch of the ascending pharyngeal artery. Immediately above this foramen is a heaping up of bone designated as the *eminentia innominata.* Behind the condyle is a *posterior condylar fossa;* it may be perforated by a foramen for the passage of a vein from the lateral sinus; both fossa and foramen are inconstant. External to the condyle is the *jugular process,* analogue of a transverse process; it lies above the transverse process of the atlas, and it presents in front the *jugular notch,* which helps form the *jugular foramen;* the right notch is usually the larger. The extremity of the process presents an irregular facet for union with the temporal bone; this union is osseous at the twenty-fifth year. The upper surface presents the end of the *lateral sulcus* (for the lateral sinus) leading to the jugular notch; here the posterior condylar foramen opens if present. On the under surface is attached the rectus capitis lateralis muscle.

The *basilar process* projects forward and upward in the middle of the base of the skull and at the top of the pharynx, increasing in thickness and diminishing in width. Superiorly is a *basilar groove* for the medulla, and at either lateral margin a shallow sulcus for the inferior petrosal sinus. Inferiorly in the middle line is the *pharyngeal tubercle* for aponeurotic attachment of the superior constrictor of the pharynx; on each side of it are attached the rectus capitis anticus major and minor muscles.

The *superior* border extends on each side from the superior to the lateral angle, is deeply serrated for articulation with the parietal bone, and forms, by this union, the *lambdoid suture.* The *inferior* border extends from the lateral to the inferior angle; its upper half is rough, and articulates with the mastoid portion of the temporal, forming the *mastoöccipital suture;* the inferior half articulates with the petrous portion of the temporal, forming the *petroöccipital suture;* these two portions are separated from each other by the jugular process. In front of this process is a deep notch, which, with a similar one on the petrous portion of the temporal, forms the *foramen lacerum posterius,* or *jugular foramen.* This notch is occasionally subdivided into two parts by a small process of bone, and it generally presents an aperture at its upper part, the internal opening of the posterior condyloid foramen.

The *superior* angle is received into the interval between the posterior superior angles of the two parietal bones; it corresponds with that part of the skull in the fetus which is called the *posterior fontanelle.* The *inferior* angle is represented by the square-shaped surface of the basilar process. At an early period of life a layer of cartilage separates this part of the bone from the sphenoid, but in the adult the union between them is osseous. The *lateral angles* correspond to the outer ends of the transverse grooves, and are received into the interval between the posterior inferior angles of the parietal and the mastoid portion of the temporal.

The Parietal Bones

The two *parietal bones* together form the median portion of the roof and sides of the skull. Each is roughly quadrilateral, and presents two surfaces (external and internal), four borders, and four angles.

The *external surface* is convex, smooth, and near its centre is an eminence called the *parietal eminence,* or *boss.* This is very prominent in young bones.

Through or just below this are the *superior* and *inferior temporal lines,* $\frac{2}{5}$ inch apart; to the superior one is attached the temporal fascia; to the inferior, the temporal muscle; below it is the *temporal surface* for origin of the temporal muscle. Near the upper border, and $\frac{4}{5}$ inch (2 cm.) from the posterior angle, the *parietal foramen* is often found. It is for the exit of a vein, and usually the entrance of a branch of the occipital artery. The *sagittal suture* between the two parietal foramina is inclined to obliteration.

The *internal surface* is concave; the deepest part is opposite the parietal eminence, and is called the *parietal fossa.* This surface is marked by grooves or canals for the meningeal vessels, which run upward and backward from the anterior inferior angle, from the middle and posterior portions of the inferior border. A shallow half-groove runs along the superior border, forming with that of the opposite side the channel for the superior longitudinal sinus. In this half-groove is found the internal opening of the parietal foramen when it exists. Near the upper border of the bone are *digital depressions* for lodgement of the Pacchionian bodies (modified tufts of arachnoid membrane).

The *anterior border,* the longest and thickest, is dentated to articulate with its fellow of the opposite side, forming the sagittal suture. The *inferior* is divided into three parts; of these, the anterior is thin and pointed, bevelled at the expense of the outer surface, and overlapped by the tip of the great wing of the sphenoid; the middle portion is arched, bevelled at the expense of the outer surface, and overlapped by the squamous portion of the temporal; the posterior portion is thick, and serrated by articulation with the mastoid portion of the temporal. The *anterior border,* deeply serrated, is bevelled at the expense of the outer surface above and of the inner below; it articulates with the frontal bone, forming the *coronal suture.* The *posterior* border, deeply denticulated, articulates with the occipital, forming the *lambdoid suture.*

The *anterior superior* angle, thin and pointed, corresponds with that portion of the skull which in the fetus is membranous, and is called the *anterior fontanelle.* The *anterior inferior* angle is thin and lengthened, being received in the interval between the great wing of the sphenoid and the frontal. Its inner surface is marked by a deep groove, sometimes a canal, for the anterior branch of the middle meningeal artery. The *posterior superior* angle corresponds with the junction of the sagittal and lambdoid sutures. In the fetus this is membranous and forms a portion of the *posterior fontanelle.* The *posterior inferior* angle articulates with the mastoid portion of the temporal bone, the occipital. It generally presents on its inner surface a small portion of the groove for the lateral sinus.

The Frontal Bone

The frontal (*frons*, forehead) arches up and back above the orbits, forming the forepart of the cranium. It *articulates* with twelve bones—the parietals and sphenoid, the malars, the nasals, superior maxillæ, lacrymals, and ethmoid. It consists of two portions, a superior vertical or frontal and an inferior horizontal, and presents three surfaces, anterior, inferior, and cerebral which is continuous in the two portions.

The *anterior surface* shows the greatest convexity on each side in the *frontal eminence*, separated by a slight depression below from the *superciliary ridge*, just above the orbit. In the middle line between the two ridges is a smooth surface, the *glabella* (without hair), also called *nasal eminence*. The *orbital arch* ends in extremities called the *internal* and *external angular processes;* the internal is slightly marked, and articulates with the lacrymal bone; the external is prominent, and articulates with the malar. At the junction of the inner and middle third of the arch is the supraorbital notch or foramen for the supraorbital nerve and vessels. The *temporal crest* springs from the outer angular process, and is continuous with the inferior temporal line on the parietal. Inferiorly are two thin horizontal laminæ, the *orbital plates*, forming the roof of the orbits and separated by the *ethmoidal notch*.

Inferior Surface.—The orbital plates are somewhat triangular, with their internal margins parallel. Close to the external angular process is the *lacrymal fossa*, and close to the inner process is the *trochlear fossa* for the pulley of the superior oblique. Between the internal angular processes is the *nasal notch*, and from its concavity the *nasal process* projects beneath the nasal bones and nasal processes of the superior maxillæ, and supports the bridge of the nose. On the posterior surface of this process are two grooves which enter into the roof of the nasal fossæ; between the grooves is a median ridge, the *nasal spine*, which descends in the septum of the nose above the perpendicular plate of the ethmoid. Along the inner margins of the ethmoidal notch are irregular depressions forming the roof of cells in the ethmoid. Each border is marked inferiorly by two grooves, completing with the ethmoid the *anterior* and *posterior internal orbital canals;*

the anterior transmits the nasal nerve from the orbit and anterior ethmoidal vessels; the posterior transmits the posterior ethmoidal vessels. The *frontal sinus* opens at the root of the nasal process. It is between the outer and inner tables, over the root of the nose and divided by a bony septum. Outside and behind the orbital surface is a rough triangular area for articulation with the great wing of the sphenoid.

Cerebral Surface.—This forms a large concavity for the anterior lobes of the cerebrum. The orbital plates are convex and marked by ridges and depressions, and are so thin as to be transparent; these plates make an angle of about 60 degrees with the upper part of the bone. From the upper margin descends the *frontal sulcus,* running into the *frontal crest* at the lower margin. At the base of the crest is usually a groove converted into the *foramen cæcum* by the approximation of the ethmoid; this is usually open in children, but blind in adults. The sides of this surface present grooves for the meningeal vessels. The thin transverse edge bounding the surface behind articulates with the greater and lesser wings of the sphenoid.

The *border of the vertical portion* is thick, strongly serrated, bevelled at the expense of the internal table above, where it rests upon the parietal bones, and at the expense of the external table at each side, where it receives the lateral pressure of those bones; this border is continued below into a triangular rough surface which articulates with the great wing of the sphenoid. The *posterior border of the horizontal portion* is thin, serrated, and articulates with the lesser wing of the sphenoid.

The Temporal Bones

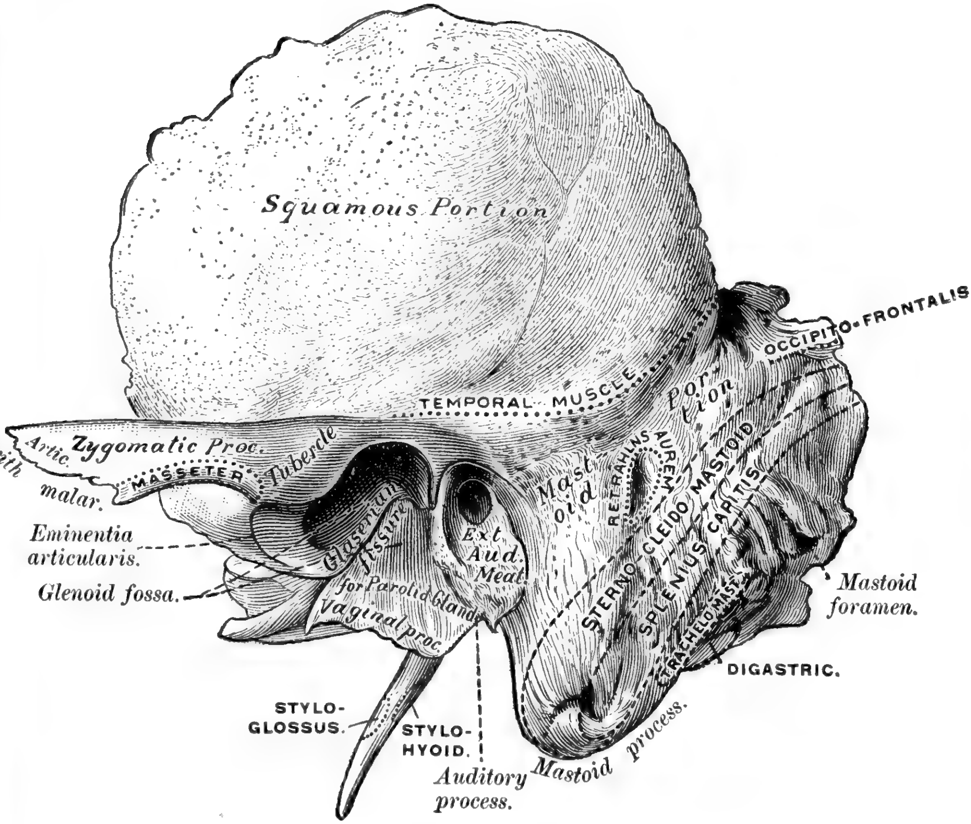
The temporal bone (*tempus,* time, as hair first becomes gray in this region, indicating age) helps form the side and base of the skull and contains the organ of hearing. It presents three parts—the *squamous, mastoid,* and *pyramidal,* which includes the *petrous* and *tympanic.* It *articulates* with five bones—posteriorly and internally with the occipital, above with the parietal, in front with the sphenoid and malar, and below with the inferior maxilla.

The **squamous portion** (scale) presents a vertical portion and a narrow horizontal portion at the base of the skull. It is limited above by an arched border describing two-thirds of a circle. The *outer surface* is vertical, with a slight convexity, and forms a part of the temporal fossa. This portion overlaps the mastoid behind. Above the aperture of the ear is a vertical groove for the middle temporal artery.

The *zygoma* is connected with the lower and outer part of the squamous portion; it is broad at its base, with surfaces looking up and down; it then twists on itself, so that it has inner and outer surfaces, upper and lower borders. The upper border is thin and longer than the inferior, which is short and arched; the anterior extremity articulates with the zygomatic process of the malar bone, overlapping it. The zygoma is attached by two roots; the *anterior,* continuous with the lower border, is a broad convex ridge directed inward, called the *eminentia articularis.* At the junction of this with the zygoma is a *tubercle* for the external lateral ligament of the lower jaw. The *posterior root* prolongs the upper border of the zygoma as the *supramastoid crest,* which becomes continuous with the lower temporal line; it is above the suture between the squama and mastoid. Between the two roots is the *glenoid fossa;* its articular portion is bounded behind by the *postglenoid process,* sometimes called the middle root of the zygoma. It is strongly developed in some mammals to prevent posterior dislocation of the lower jaw. The *inferior aspect* of the horizontal portion presents three districts—the auricular, articular, and zygomatic, from behind forward. The auricular part forms the upper concave margin of the external auditory meatus and a part of the roof of the external ear. The next portion is the *glenoid fossa,* which is divided into two parts by the transverse *fissure of Glaser,* which is a double cleft. The posterior part is non-articular, formed by the tympanic plate and lodging part of the parotid gland. The anterior part of the fossa is articular, bounded behind by the postglenoid process and in front by the eminentia articularis; it is the *fossa mandibularis,* concavoconvex for the condyle of the lower jaw. The first fissure behind the articular fossa is the petrosquamous, next comes a narrow projection of the *tegmen tympani* from the petrous, and next the petrotympanic fissure or Glaserian fissure proper; it lodges the slender process of the malleus and tympanic branch of the internal maxillary artery. Farther in, and external to the Eustachian tube, is the canal of Huguier, by which the chorda tympani nerve enters. The outer part of the Glaserian fissure is entirely closed.

In front of the articular eminence, and separated by a slight ridge from the temporal surface, is a small triangular *infratemporal surface*, entering into the zygomatic fossa.

Fig. 6



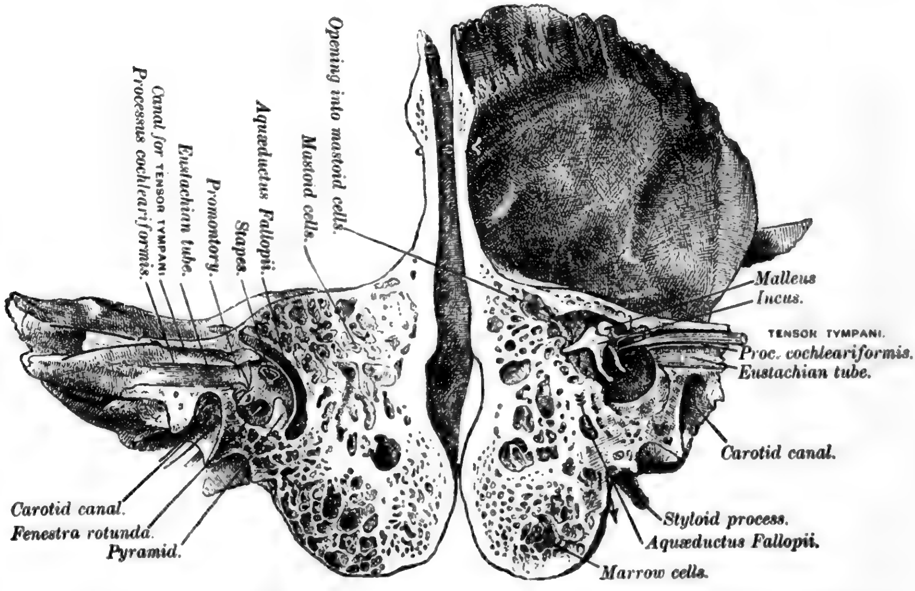
Left temporal bone: outer surface. (Gray.)

The *inner surface* of the squamous is concave and presents cerebral impressions and meningeal grooves. A narrow horizontal part helps form the anterior wall of the tympanum.

The *superior border* is thin and fluted, and overlaps the parietal bone. The *parietal notch* marks the junction of the superior border with the mastoid; the squamomastoid suture passes from this notch to the posterior edge of the external auditory meatus.

The *anteroinferior border* is thick, and bevelled above continously with the upper border at the expense of the inner surface, below at the expense of the outer—all for articulation with the great wing of the sphenoid.

FIG. 7



Section through the petrous and mastoid portions of the temporal bone, showing the communication of the cavity of the tympanum with the mastoid antrum.

The **mastoid portion** (teat-like) is rough for muscular attachment, and prolonged down behind the auditory meatus as the *mastoid process*. At the posterior border is the *mastoid foramen,* sometimes foramina, transmitting veins to the lateral sinus and a mastoid artery from the occipital; the foramen is inconstant, and may be in the occipital bone or in the mastoöccipital suture. On the inner side of the mastoid process is the *digastric fossa* for attachment of the posterior belly of the digastric, and internal to this is the *sulcus occipitalis* for lodgement of the occipital artery.

The *internal surface* shows the *fossa sigmoidea,* which is a part of the sulcus for the lateral sinus; the mastoid foramen opens into it. A section of the mastoid portion shows a number of communicating cells; below in the mastoid process they are developed after puberty and are arranged vertically. Above these is the *antrum mastoideum,* which is a horizontal cellular cavity, a part of the middle ear; its roof and posterolateral wall are formed from the petrous portion, and are continuous with the roof and side of the tympanum. Its anteromedian wall belongs to the mastoid. Below it connects with the mastoid cells; its opening into the tympanum is large and on a level with the foramen ovale, so the floor of the tympanum passes in front into the Eustachian tube and behind into the mastoid antrum. The *superior border* of the mastoid is rough, slopes back, and articulates with the posteroinferior angle of the parietal; the *posterior border* articulates with the occipital between its lateral angle and jugular process.

The **pyramidal portion** includes the petrous (stone) and tympanic (drum) portions.

The **petrous portion** is a four-sided pyramid with its base turned out, and its long axis inward, forward, and slightly downward. The axes of the two portions if prolonged would meet at the posterior edge of the nasal septum. This portion presents four borders—*superior, inferior, anterior,* and *posterior;* and four surfaces—*anterointernal, posterointernal, anteroexternal,* and *posteroexternal,* also a *base* and an *apex.* The *base* is concealed in its upper half by the squamous and mastoid, and covered below, where these diverge, by the tympanic portion. The *apex* is received into the angle between the great wing of the sphenoid and the basilar process, and presents the anterior orifice of the carotid canal, and forms the postero-external boundary of the foramen lacerum.

The *anterointernal surface* is in the middle fossa of the skull, and separated from the squamous portion by the *fissura petrosquamosa.* This surface presents a little behind its centre the *eminentia arcuata,* covering the superior semicircular canal; in front of this is a groove passing to the *hiatus Fallopii,* which leads to the aqueduct of Fallopius; it transmits the large superficial petrosal nerve and the petrosal branch of the middle meningeal artery. Outside this are a groove and small foramen for the small superficial petrosal nerve. Near the apex the wall of the carotid canal is deficient; above this is a shallow depression for the Gasserian ganglion. Between the petrosquamous fissure externally and the hiatus Fallopii and eminence of the superior semicircular canal internally is a thin lamina which roofs in the tympanum and a common canal for the Eustachian tube and tensor tympani muscle; it is the *tegmen tympani,* a process of the petrous.

The *posterointernal surface* is in the posterior fossa of the skull, and continuous with the inner surface of the mastoid. Near the centre, but nearer the upper than the lower border, is a large orifice, the *porus acusticus internus,* leading into a canal $\frac{1}{4}$ inch (6 mm.) long, which is the *internal auditory meatus;* this is terminated by the *lamina cribrosa.* A transverse ridge, *crista falciformis,* separates a small superior from a large inferior fossa. A faint perpendicular crest divides these into four fossæ. The facial nerve enters the aqueduct of Fallopius in the upper anterior fossa; the *area cribrosa superior* is the perforated part of the upper posterior fossa for the auditory nerves going to the utricle, superior, and external auditory canals; below this is the *area cribrosa media,* conveying an auditory branch to the saccule; also the *foramen singulare,* for a branch to the posterior auditory canal; in the lower anterior fossa is the *tractus spiralis foraminosus,* for the cochlear division of the auditory nerve, ending at the *foramen centrale cochleæ.*

Behind the auditory meatus is a small slit, the opening of the *aqueduct of the vestibule,* transmitting a small artery and vein and lodging a process of dura mater which encloses the *saccus endolymphaticus;* above and between these is a depression or fissure, the *subarcuate fossa,* which extends into the arch of the superior semicircular canal and represents the floccular fossa of animals.

The *posteroexternal surface* forms part of the base of the skull. Beginning at the apex is first a quadrilateral surface for the origin of the levator palati and tensor tympani muscles, the lower aperture of the carotid canal, which is first vertical and then horizontal; vertically beneath the internal auditory meatus is the three-sided opening of the aqueduct of the cochlea, which in early life transmits a vein; next behind is the *jugular fossa,* which forms the jugular foramen when opposite the jugular notch of the occipital.

In front of the bony ridge, between the carotid canal and jugular fossa, is a small foramen for *Jacobson's nerve* (from the glossopharyngeal) to the tympanic plexus; this foramen usually splits to give exit to the small deep petrosal (*caroticotympanicus superior*) from the tympanic to the carotid plexus. Externally in the ascending part of the carotid canal is a small foramen for the *caroticotympanicus inferior,* a sympathetic nerve going from the carotid plexus to the tympanic. On the outside of the jugular fossa is a foramen for *Arnold's nerve* from the pneumogastric; its canal runs through the petrous transversely and out, and splits into two, an inner to meet the facial canal, $\frac{1}{5}$ inch (5 to 6 mm.) above the stylomastoid foramen, and the other to open at the tympanicomastoid (auricular) fissure.

Behind the jugular fossa is the *jugular facet,* for articulation by synchondrosis with the jugular process of the occipital. Externally is the *styloid process,* enclosed between the layers of the *vaginal process.* It gives attachment to three muscles and two ligaments. Between the styloid and mastoid processes is the *stylomastoid foramen,* the end of the aqueductus Fallopii, which passes first out and back over the labyrinth, then in and back, and then down to terminate here; the stylomastoid artery enters and the facial nerve leaves this foramen.

The *anteroexternal surface* is free anteriorly for a short distance, and articulates with the greater wing of the sphenoid; posteriorly it is concealed by the tympanic plate.

At the angle between the squamous and petrous portions is the opening of a canal, the musculotubarius, incompletely divided into two by a projecting lamella, the *cochleariform process* or *septum tubæ.* The upper groove is for the tensor tympani muscle, and the lower is the bony wall of the Eustachian tube. This common canal is covered by the tegmen, its inner wall is the anteroexternal surface of the petrous, and its floor and outer wall are the tympanic plate. The septum tubæ rarely reaches the opposite wall, and rises from the anterior wall of the carotid canal. This wall is made of two thin lamellæ with diploë between, in which runs the small deep petrosal nerve. The *superior border* is grooved for the superior petrosal sinus, and gives attachment to the tentorium cerebelli. The *posterior border* presents on its inner portion a half-groove for the inferior petrosal sinus, and externally the margin of the jugular fossa. From the apex, where a bony projection often overhangs the inferior petrosal groove, a fibrous band, the *petrosphenoidal ligament,* extends to the side of the dorsum sellæ, and completes a foramen for the inferior petrosal sinus and sixth nerve. The *anterior border* has two parts—an outer, forming the petrosquamous fissure, and an inner free portion to form the petrosphenoidal suture. The *inferior border* is largely concealed by the tympanic and petrous portions; near the apex it is indistinct, and here the bone is rather three-sided.

The **tympanic portion** is beneath the petrous and between the mastoid and squamous. At birth it is a ring from which is developed the *tympanic plate.* The thickened outer extremity of this plate is the *external auditory process,* a curved, uneven lamina forming the anterior and inferior wall of the *external auditory meatus* and tympanum. The upper margin of the plate is concealed by the petrous and forms the posterior boundary of the fissure of Glaser. Its lower margin descends as a sharp edge, the *vaginal process;* it is continuous with the inferior border of the petrous portion.

The Sphenoid Bone

The sphenoid bone (wedge-like) is placed across the base of the skull near its middle, and binds the other cranial bones together. It helps form the cavities of the cranium, orbits, and nasal fossæ, and has to do with six pairs of cranial nerves. It resembles a bat with outstretched wings, and consists of a *body, greater* and *lesser wings,* and *pterygoid processes.* It *articulates* with twelve bones, all those of the cranium, and five of the face; posteriorly with the occipital and temporals, anteriorly with the ethmoid, palatals, frontal, and malars; laterally with the temporals, frontal, and parietals; inferiorly with the vomer and palatals, and sometimes with the superior maxillæ.

The *body* is followed into two cavities separated by the *sphenoidal septum,* and opening anteriorly into the upper and back part of the nasal fossæ behind the superior turbinate bone.

The *superior surface* presents in front the *ethmoidal spine,* articulating with the cribriform plate of the ethmoid. On either side of this surface is a slight depression for the olfactory lobe, and its posterior margin is a transverse ridge—the *limbus sphenoidalis.* Behind this, on a lower plane, is the *optic groove,* terminating on either side in the *optic foramen.* Next is the *olivary eminence* (*tuberculum sellæ*), and next the *pituitary fossa,* or *sella Turcica* (Turkish saddle); it is occasionally bounded in front by two *middle clinoid processes;* behind is a square lamina, the *dorsum sellæ* or *dorsum ephippii* (back of saddle), which slopes posteriorly down and back into the basilar groove; this slope is the *clivis Blumenbachii* (Blumenbach's hill).

The upper angles of this lamella project over the fossa as the *posterior clinoid processes;* the sides are grooved for the sixth pair of nerves. The *sides* of the body present a winding groove curved like the letter *f*, for the carotid artery in the cavernous sinus. Behind its commencement, at the lower lateral angle of the dorsum sellæ, is the *petrosal process* of the *sphenoid,* to fit against the apex of the petrous; opposite this, on the other side of the groove, is a tongue-like process, the *lingula sphenoidalis.*

The *posterior surface* is quadrilateral, and united to the basilar process by cartilage in early life, and by bone after the twenty-fifth year.

The *anterior surface* is marked in the middle line by the *sphenoidal crest,* which articulates with the perpendicular plate of the ethmoid. On each side of the crest are a mesial and a lateral part; the lateral shows half-cells, to be completed by the ethmoid and orbital plate of the palatal; the mesial part is smooth, and gives entrance anteriorly into the sphenoidal sinus, and forms part of the roof of the nose.

The *inferior surface* presents the *rostrum* (beak), which continues the sphenoidal crest and fits between the alæ of the vomer.

The *sphenoidal turbinate* bones (*spongy bones, conchæ sphenoidales, bones of Bertin*) form a considerable part of the anterior wall of the body of the sphenoid. They are curved and triangular, with apex backward. A small portion of them sometimes appears on the inner wall of the orbit between the ethmoid, frontal, sphenoid, and palate bones.

Each lateral surface of the body is mostly occupied by the attachment of the greater wings, except in front a free surface bounds the sphenoidal fissure and forms the hindermost part of the inner wall of the orbit.

The *small* or *orbital* wings (processes of Ingrassias) extend horizontally outward on a level with the forepart of the superior surface of the body; the extremity of each is pointed and comes almost into contact with the great wing. The inferior surface forms the upper boundary of the sphenoidal fissure and part of the roof of the orbit. The anterior border articulates with the orbital plate of the frontal; the posterior is free, and forms the boundary between the anterior and middle fossæ of the skull, and terminates internally in the *anterior clinoid process.* Between this clinoid process and the olivary eminence is a semicircular notch in which the carotid groove ends. The optic foramen perforates the base of the wing, the parts above and below being called its roots.

The *great* or *temporal wings* project out and up from the sides of the body; the back part of each is horizontal and fills the angle between the squamous and petrous portions of the temporal; from its extremity projects downward the *spinous process.* The forepart is vertical and three-sided, and lies between the cranial cavity, the orbit, and temporal fossa.

The *cerebral surface* is concave, and forms part of the middle fossa of the skull.

The *external surface* (temporozygomatic) is divided by the *infratemporal crest* into a lower part looking down into the zygomatic fossa, and an upper part looking out into the temporal fossa.

The *anterior surface* looks forward and inward, and consists of the *orbital plate* for the external wall of the orbit, and of a smaller portion above the pterygoid process which looks into the sphenomaxillary fossa and is perforated by the *foramen rotundum.*

The *posterior border* near the body bounds the foramen lacerum, and in its lateral part articulates with the petrous, forming a groove beneath for the cartilaginous portion of the Eustachian tube. The *external border,* commencing at the spinous process, articulates with the squamous, and above it overlaps the anterior inferior angle of the parietal bone. In front of this is a triangular surface formed by the upper margins of the cerebral, orbital, and temporal surfaces. The *anterior margin* articulates above with the malar; below this is a free horizontal edge separating the zygomatic from the sphenomaxillary surface. Above and internally the orbital and cerebral surfaces meet at a sharp border, which forms the inferior boundary of the sphenoidal fissure, and often shows a bony projection for the lower head of the external rectus.

The *pterygoid* (wing-like) *processes* project downward and forward (angle of 110 to 115 degrees) from the junction of the body and great wings. Some consider them to rise from two roots, one representing a transverse process, one a rib, and the Vidian canal, the costotransverse foramen. Each consists of two plates united in front and diverging behind, forming the *pterygoid fossa* for the origin of the internal pterygoid muscle. The external plate is broad and extends out and back, and gives origin by its outer surface to the external pterygoid muscle. The internal plate is long and narrow, and prolonged below into the *hamular process* (hook-like), around which plays the tendon of the tensor palati, muscle. The upper part of the inner plate turns in beneath the body, and remains distinct as a slightly raised edge, the *vaginal process,* which meets the everted margin of the vomer. At the angle of the vaginal process with the internal plate is a groove which, with the sphenoidal process of the palate, forms the *pterygo-palatine canal.* Posteriorly, at the base of the inner plate, is the *pterygoid tubercle,* to the inner side of and below the Vidian canal; between this and the pterygoid fossa is the *scaphoid fossa* for the origin of the tensor palati muscle. Lower down, on the posterior margin of the plate, is the *processus tubarius,* which supports the cartilage of the Eustachian tube. Between the lower ends of the plates is the *pterygoid notch,* occupied by the pyramidal process of the palate bone.

Fissures and Foramina of the Sphenoid.—Each half presents a fissure, four foramina, and a canal. The *sphenoidal fissure* is the oblique interval between the great and small wings, closed externally by the frontal bone. It opens into the orbit and transmits the third, fourth, ophthalmic division of the fifth, and the sixth cranial nerves, some sympathetic filaments from the cavernous plexus, the orbital branch of the middle meningeal artery, recurrent branch of the lacrymal artery, and the ophthalmic vein. Above and to the inside of this fissure is the *optic foramen,* piercing the base of the small wing and transmitting the optic nerve and ophthalmic artery. The *foramen rotundum* pierces the great wing below the sphenoidal fissure and transmits the superior maxillary nerve. Behind and external to this is the *foramen ovale,* near the posterior margin of the great wing, sometimes incomplete; it transmits the inferior maxillary nerve, the small meningeal artery, and sometimes the small superficial petrosal nerve. The *foramen spinosum* pierces the great wing near the posterior angle, and transmits the middle meningeal artery and nervus spinosus, a recurrent branch of the inframaxillary. From the foramen spinosum projects backward a thin horizontal *sphenopetrosal lamina,* which reaches the upper border of the Eustachian canal on the petrous.

The *Vidian canal* pierces the base of the internal pterygoid plate anteroposteriorly; it passes from the foramen lacerum to the sphenomaxillary fossa, transmitting the Vidian nerve and vessels.

A spicule of bone may connect the middle clinoid process (when present) with the anterior, forming a *caroticoclinoid foramen* for the carotid artery. Interclinoid ligaments are normally present beneath the dura. The outer pterygoid plate may be connected by bone or ligament with the spinous process. The *foramen of Vesalius* for an emissary vein is sometimes present on the inner side of the foramen ovale. The *canaliculus innominatus* is sometimes present for the small superficial petrosal nerve internal to the foramen spinosum.

The Ethmoid Bone

The *ethmoid* (sieve-like) projects down between the orbital plates of the frontal, and enters into the formation of the cranium, orbits, and nasal fossæ.

It *articulates* with thirteen bones—fifteen including the sphenoidal turbinates—the frontal, sphenoid, and vomer, the nasals, lacrymals, superior maxillæ, palatals, and inferior turbinate bones.

It consists of thin plates enclosing irregular cells—a *vertical plate* and two *lateral masses* united above by the horizontal *cribriform plate.* The *vertical plate* forms the upper third of the nasal septum, and presents grooves and canals for the olfactory nerves. Its superior border appears in the cranial cavity as the *crista galli* (cock's comb); posteriorly this process is thin, and anteriorly is broadened into two alar processes, between which is usually a groove completing the foramen cecum with the frontal. If the vertical plate be deflected below the cribriform, the crista galli is inclined in the opposite direction. The anterior border of the plate articulates with the nasal spine of the frontal and with the nasal bones; the inferior border in front with the triangular cartilage of the nose, and behind with the vomer; the posterior margin with the sphenoidal crest (Fig. 9).

Each *lateral mass* or *labyrinth* encloses three sets of spaces—the *anterior, middle,* and *posterior* ethmoidal cells; they do not communicate with each other. Externally is the paper-like *orbital plate,* or *os planum* (*lamina papyracea*), closing in the middle and posterior cells; it articulates in front with the lacrymal, behind with the sphenoid, above with the frontal, and below with the superior maxilla and palate bones. On this aspect below the plate is a groove belonging to the middle meatus of the nose; it turns up anteriorly, and is continued by the *infundibulum* through the anterior ethmoidal cells to the frontal sinus; the middle cells open into the horizontal part of the groove. The lateral mass in front of the orbital plate is covered in by the lacrymal; from this part the *uncinate process* curves back, down, and out, helping to close the orifice of the antrum; it articulates below with the ethmoidal process of the inferior turbinate.

The *inner aspect* of each lateral mass is in the outer wall of the nasal fossa. Above is a channel, the *superior meatus,* passing from behind to about the middle of the bone; it communicates with the posterior cells. The plate overhanging it is the *superior turbinate process* or *superior spongy bone* (concha suprema); the space above that is in the roof of the nose. Below the groove is the *inferior turbinate process* of the ethmoid or *middle spongy bone* (concha inferior), rolling convexly toward the nasal fossa; it forms the lower border of the lateral mass.

Two grooves cross the upper margin of the lateral mass, forming with the frontal the two internal orbital or anterior and posterior ethmoidal canals. Posteriorly the mass is ankylosed with the sphenoidal spongy bone.

The *cribriform plate* occupies the ethmoidal notch of the frontal. It presents the *olfactory groove* on each side of the crista galli and foramina for the olfactory nerves; the foramina of the middle set are few and are simple perforations; in the external and internal sets they are more numerous, and are orifices of small canals which subdivide on the vertical plate and lateral mass. Anteriorly is a fissure close to the base of the crista galli, and external to it a notch connecting with the anterior internal orbital canal for the passage of the nasal nerve and anterior ethmoidal artery from the orbit to the cranium, and thence to the nasal fossa.

THE BONES OF THE FACE

The Superior Maxillary Bones

The superior maxilla is the principal bone of the face, supporting the upper teeth of one side, helping to form the hard palate, floor of the orbit, floor and outer wall of the nasal fossa. It *articulates* with nine or ten bones—with its fellow, with the nasal, frontal, lacrymal, ethmoid, palate, malar, vomer, inferior turbinate, and sometimes with the sphenoid at the outer extremity of the sphenomaxillary fissure. There are a body and four processes for description. The *body* is a hollow half-cylinder, presenting an external surface subdivided into an anterior and a posterior, an internal and a superior; the processes are nasal, alveolar, malar, and palatal.

The *body* encloses the *antrum* of Highmore, which opens into the middle meatus of the nose. The *anterior* or *facial* surface is marked below by eminences corresponding to fangs of the teeth. Internal to the eminence for the canine is the *incisor* or *myrtiform fossa;* external to it is the deeper *canine fossa;* above the latter, below the margin of the orbit, is the *infraorbital foramen.* The inner margin of this surface is cut by the *nasal notch,* the sharp edge of which is prolonged below into the *anterior nasal spine.*

The *posterior* or *zygomatic* surface looks into the zygomatic and sphenomaxillary fossæ; it presents two or more apertures of the *posterior dental canals;* below and posteriorly is a rough tuberosity, the *maxillary tuberosity.* At the junction of this surface with the nasal and orbital is a small triangular space on which the orbital process of the palate rests, the *palatine trigone* (Henle).

The *internal* or *nasal surface* (Fig. 8) presents in front the *inferior turbinate crest;* below it is the smooth concavity of the inferior meatus; above it a small surface forming the *atrium* (entry) of the middle meatus. Behind the nasal process is the *lacrymal groove,* ½ inch long, inclined down and out, opening into the inferior meatus; the groove is converted into the *canal of the nasal duct* by the lacrymal and inferior turbinate. Behind it is the opening of the antrum; above this are small half-cells belonging to the middle ethmoidal set. Behind the opening of the antrum the surface is rough for articulation with the palate bone, and traversed by a groove running down and forward, forming with the palate the *posterior palatine canal,* for the posterior palatine vessels, anterior and external palatine nerves.

The *orbital surface* is triangular and flat; externally is a rough surface for the malar; internally is first the *lacrymal notch,* and behind it a pretty straight margin for the ethmoid and orbital process of the palate. The posteroexternal border is free and bounds the sphenomaxillary fissure. The *infra-orbital groove* commences well back on this surface, leading to a canal of the same name, which opens anteriorly at the *infraorbital foramen;* from the canal are given off the *anterior* and *middle dental* canals in the substance of the bone.

The *nasal process* projects up, in, and back; its external surface is smooth; the higher part of the inner surface completes the anterior ethmoidal cells; below this the surface is crossed by the *superior turbinate crest* (agger nasi) for the inferior turbinate process of the ethmoid (middle spongy bone). The anterior border articulates with the nasal bones and above with the frontal; posteriorly is a continuation of the *lacrymal groove,* bounded internally by a sharp edge articulating with the lacrymal, and externally by a smooth border; where this border joins the orbital surface is the *lacrymal tubercle.*

The *alveolar process* is thick and hollowed into eight alveoli. The *malar process* is triangular, continuous in front and behind with the facial and zygomatic surfaces of the body. Superiorly it is rough for the malar; the inferior border forms a thick buttress opposite the first molar.

The *palate process* with its opposite forms three-fourths of the hard palate. Above, it is concave transversely, and forms part of the floor of the inferior meatus. Below, it is arched, and shows lateral grooves for nerves and vessels; its posterior extremity falls short of that of the alveolar arch, and the space is filled by the palate bone. The inner border rises into a *nasal crest* which receives the vomer; in front a more elevated part is the *incisor crest*, prolonged into the anterior nasal spine. By the site of the incisor crest is a foramen, becoming a groove; when the bones are united there is one orifice below, with right and left branches above, called the *incisor foramina*, or *foramina of Stetson*, for the transmission of arteries. The lower aperture is the *anterior palatine fossa;* in the middle line, opening into it, are the *foramina of Scarpa*, the left nasopalatine nerve passing through the anterior one and the right through the posterior. From the anterior palatine fossa are seen two sutures passing to the interval between the canine and lateral incisor tooth; the sutures are to be seen in the inferior meatus. They mark off the *intermaxillary bone*, and include the whole thickness of the alveolar processes, the nasal spine, and sockets for the incisor teeth. No trace of the suture is seen on the facial surface, as an outgrowth, the *incisor process*, forms the front wall of the incisor sockets.

The *maxillary sinus*, or antrum, is irregularly pyramidal; the base is at the nasal surface of the body and the apex extends into the malar process. Its aperture is closed in part by the uncinate process of the ethmoid, the ethmoidal process of the inferior turbinate, and the maxillary process of the palate behind; the lacrymal in front rarely assists. The alveolus of the first molar is most prominent in the floor.

The Palate Bone

This bone is L-shaped, and forms the back part of the hard palate and the lateral wall of the nose between the superior maxilla and internal pterygoid plate. It presents a horizontal, a vertical plate, and three processes. It *articulates* with six bones—its fellow, the superior maxilla, the ethmoid, sphenoid, vomer, and inferior turbinate.

The **horizontal plate** is thick, of a quadrilateral form, and presents two surfaces and four borders. The *superior* surface, concave from side to side, forms the back part of the floor of the nostril. The *inferior* surface, slightly concave and rough, forms the back part of the hard palate. At its posterior part may be seen a transverse ridge, more or less marked, for the attachment of the aponeurosis of the tensor palati muscle. At the outer extremity of this ridge is a deep groove converted into a canal by its articulation with the tuberosity of the superior maxillary bone, and forming the *posterior palatine canal.* Near this groove the orifices of one or two small canals, *accessory posterior palatine,* may frequently be seen. The *anterior* border is serrated, bevelled at the expense of its inferior surface, and articulates with the palate process of the superior maxillary bone. The *posterior* border is concave, free, and serves for the attachment of the soft palate. Its inner extremity is sharp and pointed, and, when united with the opposite bone, forms a projecting process, the *posterior nasal spine,* for the attachment of the azygos uvulæ. The *external* border is united with the lower part of the perpendicular plate almost at right angles. The *internal* border, the thickest, is serrated for articulation with its fellow of the opposite side; its superior edge is raised into a ridge which, united with the opposite bone, forms a crest in which the vomer is received.

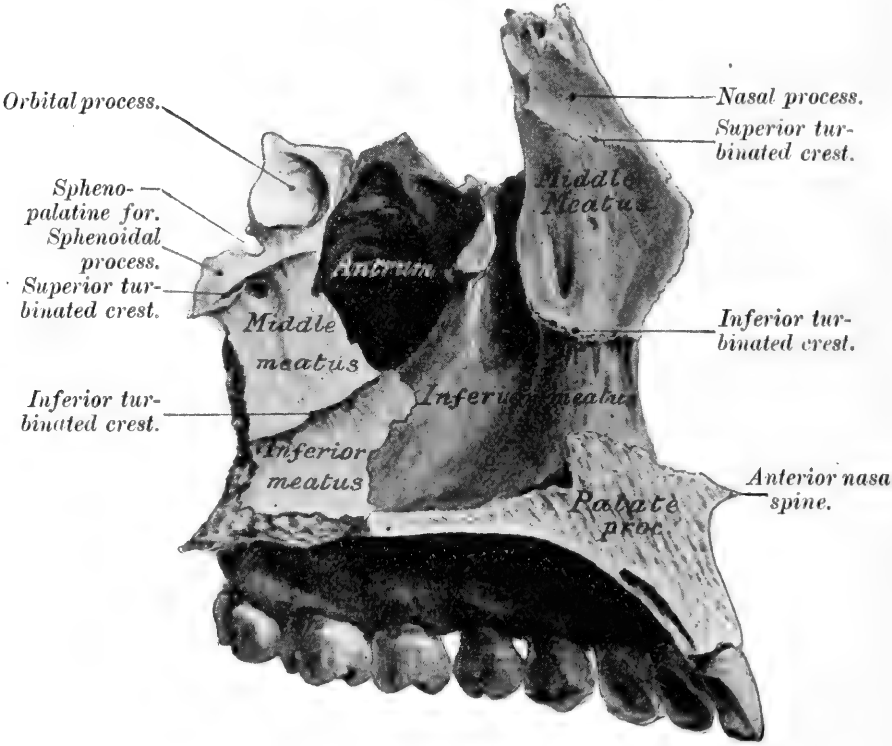
The **vertical plate** is thin; its nasal surface is divided into two parts by the inferior turbinate crest for the inferior turbinate bone; the middle meatus is above it and the inferior below. At the upper part is the *superior turbinate crest* for the middle spongy bone, and above this a groove in the superior meatus. The external surface presents above and behind a smooth surface, forming the inner wall of the pterygomaxillary fissure, and leads to the *posterior palatine groove.* In front of the groove the surface is applied to the superior maxilla and sends the *maxillary process* forward, closing in the lower back part of the opening of the antrum. Behind the groove the surface articulates below with the maxilla and above with the pterygoid process.

The *pyramidal process* or *tuberosity* juts out behind and fits between the pterygoid plates; it presents posteriorly a smooth middle district entering into the pterygoid fossa; internal to it is a groove for the internal pterygoid plate, and externally a rough area for the external plate. Part of the tuberosity appears in the zygomatic fossa. Inferiorly, close to the horizontal plate, are the *posterior* and *external accessory palatine canals.*

The *orbital process* rests on the anterior margin of the vertical plate; it has five surfaces, three articular, and two, the superior and external, are free.

The superior surface forms the posterior angle of the floor of the orbit; the external looks into the sphenomaxillary fossa; the anterior articulates with the maxilla, the internal with the ethmoid, and the posterior with the sphenoid. The process is usually hollow, and completes a posterior ethmoidal cell or may open into the sphenoidal sinus.

FIG. 8



Palate bone *in situ.*

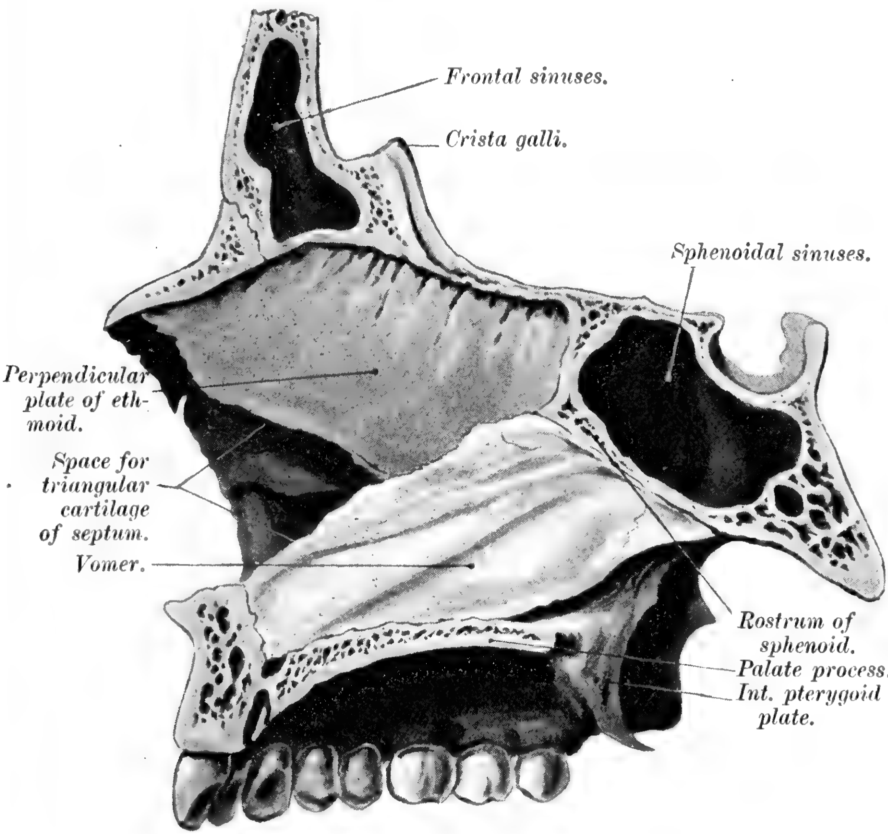
The *sphenoidal process* curves up and in from the posterior part of the vertical plate. It has three surfaces: the posterior is in contact with the under surface of the body of the sphenoid, and is grooved for the *pterygopalatine canal;* the internal surface looks into the nasal fossa and touches the ala of the vomer; the external looks into the sphenomaxillary fossa.

The *sphenopalatine notch* is between these two processes, converted by the body of the sphenoid into a foramen of the same name.

The Vomer

The vomer (ploughshare) is thin and quadrilateral, and placed vertically between the nasal fossæ. The upper and posterior borders, and the anterior and inferior, are of nearly equal lengths. It *articulates* with six bones—the sphenoid, ethmoid, two palate, two superior maxillary—and with the septal cartilage of the nose.

Fig. 9



Vomer *in situ*.

Each surface presents a groove leading the nasopalatine nerve to the foramen of Scarpa. The superior border divides into two alæ, which receive the rostrum of the sphenoid between them; each ala meets the vaginal process of the sphenoid and the sphenoidal process of the palate.

There are usually three vomerobasilar canals—a median, between ala and rostrum for nutrient vessels; an upper lateral one, between the body of the sphenoid and root of the vaginal process, carrying vessels to the sphenoidal cells; a lower lateral one, between the body of the sphenoid and the sphenoidal process of the palate, carrying vessels and nerves from the nasal and sphenomaxillary fossæ to the upper pharynx.

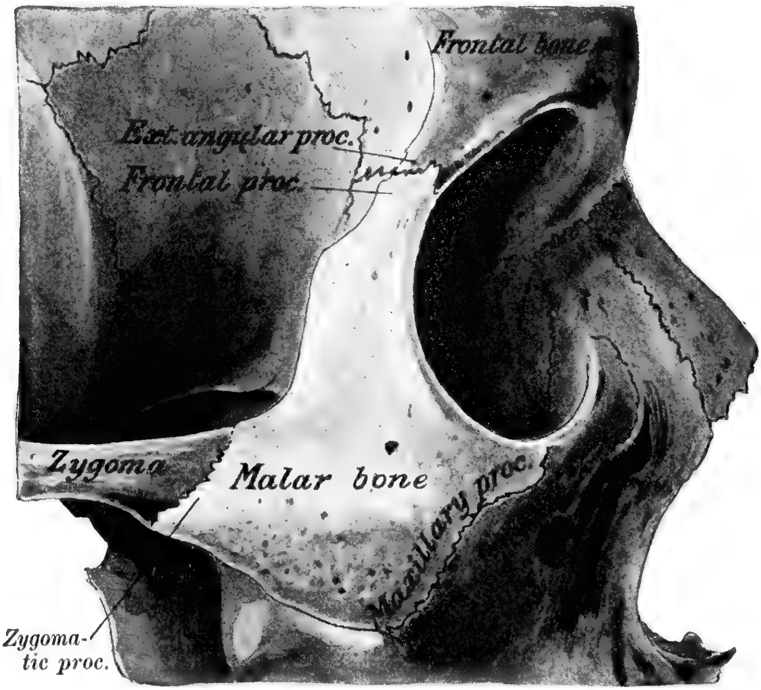
The anterior border is grooved in its lower half for the septal cartilage; in its upper half it is ankylosed on one or both sides, usually the right, with the perpendicular plate of the ethmoid. At the inferior anterior angle is a short vertical edge to fit in behind the incisor crest of the maxillæ; from its upper end a process runs forward in the groove of the crest, and from its lower end a point may project down between the incisor foramina. The inferior border articulates with the nasal crest of the maxillæ and palate bones; the posterior border is rounded, thin, concave from above downward, and free, and separates the posterior nares.

The Malar Bones

This cheek bone separates the orbit from the temporal fossa and *articulates* with four bones—the frontal, sphenoid, temporal, and superior maxillary. It is quadrangular, with the angles directed vertically and horizontally; it may be thought of as formed of a triangular orbital plate united at a sharp angle to a quadrangular malar plate. The *outer surface* presents a little below the centre the *malar tuberosity*, and above this the orifice of the malar canal. The *inner surface* is concave, looks into the temporal and zygomatic fossæ, and presents a roughness in front and below for articulation with the superior maxilla. The *upper angle* or *frontal process* is serrated for the external angular process of the frontal. The *temporal* border behind this is sinuous and continuous with the upper border of the zygoma.

The *posterior angle* or *temporal process* has the zygoma resting upon and articulating with it. The posteroinferior border, the *masseteric*, completes the lower edge of the zygomatic arch; the anteroinferior border, the *maxillary*, and a rough part of the inner surface, articulate with the malar process of the superior maxilla. The *orbital* border is excavated, and forms a great part of the orbital margin, ending internally just above or inside the infraorbital foramen. From this the *orbital process* projects back, forming the forepart of the outer wall, and enters the external portion of the floor of the

FIG. 10



Malar bone *in situ*.

orbit, articulating with the great wing of the sphenoid and orbital plate of the superior maxillary. On the orbital surface are the openings of two canals—the *temporal* opening on the temporal surface, and the *malar* opening on the facial; they transmit the temporomalar branches of the superior maxillary nerve.

The anterior extremity of the sphenomaxillary fissure may be completed in one of three ways—by the malar in more than half the cases, by the articulation of the sphenoid with the superior maxilla, or by a Wormian bone.

The antrum of Highmore may extend into the malar.

The Nasal Bones

The two form the bridge of the nose, and each *articulates* with four bones—the frontal, superior maxillary, ethmoid, and its fellow. They are narrow and thick above, broader and thinner below. They articulate above with the inner part of the nasal notch of the frontal.

The inferior border is free, and gives attachment to the lateral nasal cartilage; it usually has a small notch near the inner end. The external border is longest, and articulates by means of small teeth with the nasal process of the superior maxilla.

The internal border meets its fellow in a somewhat irregular internasal suture, which commonly deviates to one side at the upper end. Posteriorly the two form a crest which rests from above down on the nasal process of the frontal, the vertical plate of the ethmoid, and the septal nasal cartilage. The facial surface is convex below and concave above, and presents vascular foramina.

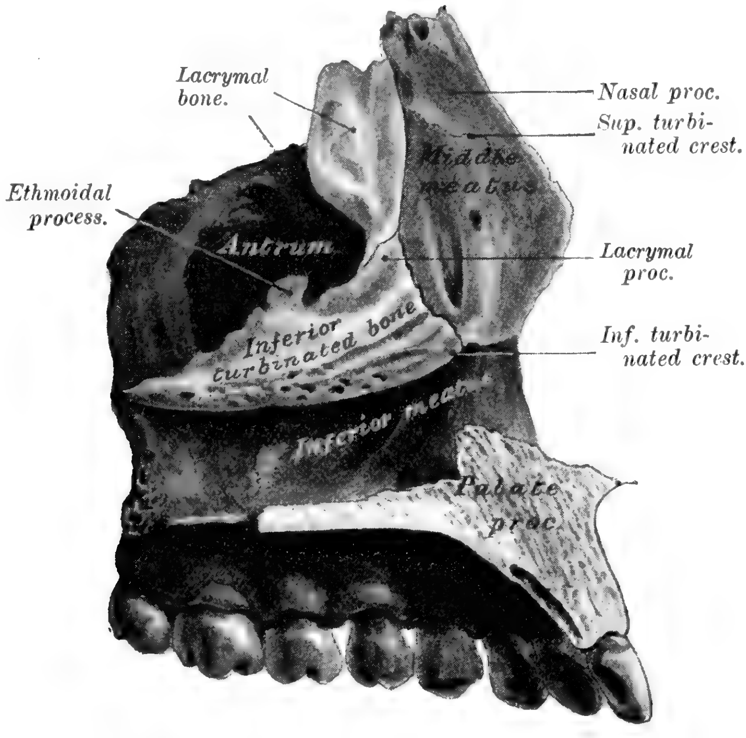
The posterior surface is concave, and a little external to its centre is a longitudinal groove for the nasal nerve.

The Lacrymal Bones

The lacrymal, or *os unguis,* is a thin scale, like a finger nail, at the anterior and inner part of the orbit. It *articulates* with four bones—frontal, ethmoid, superior maxilla, and inferior turbinate. It presents two surfaces and four borders. Its *external surface* is divided by a vertical ridge, the *lacrymal crest;* in front of it is the lacrymal groove, and this part is prolonged below as the *descending process* to articulate with the inferior turbinate; behind the crest the surface is smooth and forms part of the orbit, and is produced below into the *hamular process,* which comes forward into the lacrymal notch of the superior maxilla and bounds the outer side of the orifice of the nasal duct. The *internal surface* is a depressed furrow completing above some of the anterior ethmoidal cells, and below it looks into the middle nasal meatus.

Of the *four borders,* the *anterior* is the longest and articulates with the nasal process of the superior maxillary bone. The *posterior,* thin and uneven, articulates with the os planum of the ethmoid. The *superior,* the shortest and thickest, articulates with the internal angular process of the frontal bone. The *inferior* is divided by the lower edge of the vertical crest into two parts—the posterior part articulates with the orbital plate of the superior maxillary bone; the anterior portion is prolonged downward into a pointed process which articulates with the lacrymal process of the inferior turbinated bone and assists in the formation of the lacrymal canal as described under *external surface.*

FIG. 11



Inferior turbinated bone and lacrymal bone *in situ.*

The Inferior Turbinated Bones

The inferior turbinate or spongy bone projects like a shell into the nasal cavity, separating the middle from the inferior meatus. Its convexity looks in and its lower margin is rolled on itself. Its attached margin articulates in front with the inferior turbinate crest of the superior maxilla, and then ascends abruptly as the *lacrymal process* to complete the lacrymal canal. Behind this, and nearer the back than the front, the bone is folded down as the *maxillary process*, looking over the aperture of the antrum, and forming part of its inner wall; on the upper border of this process is the *ethmoidal process*, which articulates with the uncinate of the ethmoid. Posteriorly, the bone is attached to the inferior turbinate crest of the palate; the posterior extremity is elongated and pointed, the anterior flat and broad.

The bone *articulates* with the superior maxilla, lacrymal, ethmoid, and palate. No muscle is attached to it. The negro may have four turbinate bones.

The Inferior Maxillary Bone (Mandible)

The *lower jaw*, or *mandible*, is the strongest bone of the face, and *articulates* with the glenoid fossæ of the temporals. It consists of a curved horizontal portion or *body* and two ascending branches or *rami*. The *body* shows in the median line in front a faint vertical ridge, the symphysis of two originally distinct pieces; this expands below into the *mental protuberance*, which presents a prominence on each side called the *mental tubercle*. The superior or alveolar border is hollowed out into sockets for teeth. The inferior border, or *base*, is thick and rounded, and projects beyond the superior. Below the incisor teeth is the *incisor fossa;* more externally is the *mental foramen* midway between the upper and lower borders, under the interval between the two bicuspids; it is the anterior opening of the dental canal. Below the foramen the *external oblique line* runs up and back from the mental tubercle to the anterior margin of the ramus behind the teeth. The *deep surface* of the body presents inferiorly near the symphysis an oval fossa for the attachment of the digastric muscle; above it are the *mental spines*, the lower being a median ridge for the geniohyoid muscles, and the upper a pair of tubercles for the geniohyoglossi; there may be four tubercles (: :) or two (˙˙) or a vertical ridge (❙) or one prominence (˙). Above them a small foramen penetrates the bone, and above this a narrow median groove marks the symphysis. Below the mental spines, and passing up and back to the ramus, is the *internal oblique line* or *mylohyoid ridge,* for the mylohyoid muscle and a slip of the superior constrictor of the pharynx. Above this line is a fossa for the sublingual gland, and below it another for the submaxillary.

The *ramus* is thinner than the body, and where its posterior border meets the base it forms the slightly everted *angle.* The *external surface* is flat, and near the angle it shows oblique lines for tendinous attachment of the masseter muscle. At the centre of the *internal surface,* on a level with the crowns of the molar teeth, is the *inferior dental foramen,* leading to the *dental canal;* the inner margin of the foramen is sharp anteriorly, and called the *lingula mandibulæ.* Beginning at the notch behind the lingula is the *mylohyoid groove* (sometimes a canal), terminating below the hinder end of the mylohyoid ridge. Behind and below this is a rough surface for the internal pterygoid muscle. On the upper border of the ramus are two processes —the *condyle* for articulation and the *coronoid* for muscular attachment; they are separated by the *semilunar* or *sigmoid* notch. The *condyle* passes up from the posterior part of the ramus, supported on a constricted *neck,* on the front of which internally is a depression for the external pterygoid muscle ($\frac{1}{3}$ inch; 8 mm.); below the articular surface there may be an external tubercle for the external lateral ligament. The condyle is convex, transversely elongated, and the axes of the two would meet at the anterior margin of the foramen magnum. The *coronoid* process passes up from the forepart of the ramus, inclined out and somewhat beak-shaped; by its apex, sharp margins, upper and anterior part of the external surface, and inner surface, it gives attachment to the temporal muscle.

The anterior border of the ramus shows three oblique ridges—an external one to the end of the external oblique line; internal to that is a groove bounded posteriorly by a ridge passing from the internal oblique line to the middle aspect of the coronoid; at the lower part of the groove, extending a short distance to the outer side of the alveolus, is the third or *buccal* line.

The lower jaw consists of a thick shell of compact tissue enclosing cancellous tissue; the dental canal in its posterior two-thirds lies close to the inner compact layer; it is prolonged beyond the mental foramen under the canine and incisor teeth. There may be two dental canals. The angle of the jaw in the adult is about 120 degrees; in infancy, 140 degrees or more; in old and toothless jaws, it is increased. These changes are due to development, absorption of the alveolar arch, and strength of the masseter muscles.

The Skull as a Whole

The Sutures of the Skull

The skull bones are closely fitted by uneven edges, there being interposed a little fibrous tissue continuous with the periosteum; the dentations are confined to the external table, the edges of the inner table lying only in apposition. The lower jaw has a movable articulation, differing from the others. The sutures around three sides of the parietal bones have special names—between the two is the *sagittal,* behind them the *lambdoid,* in front of them the *coronal.*

All the sutures may be arranged in three groups—a *median longitudinal,* a *lateral longitudinal,* and a *vertical transverse.* The first consists of the sagittal, and in the infant the frontal; the second begins in the median line in front, and includes on each side the frontonasal, frontomaxillary, frontolacrymal, frontoethmoidal, frontomalar, frontosphenoidal, sphenoparietal, squamoparietal, and mastoparietal; the third comprises the coronal and sphenosquamous, the lambdoid and occipitomastoid, and also the transverse sutures at the base of the skull.

After about thirty years of age many sutures close, union taking place on the inner surface first; the parts to close first are the sagittal suture between the parietal foramina and the lower ends of the coronal suture.

Wormian Bones.—These *ossa triquetra, ossa suturarum,* are irregular ossifications between cranial bones rarely found in the face. They are usually symmetrical, and are most common in the lambdoid suture, occupying the place of the superior angle of the occipital bone; may be at either anterior angle of the parietals. They usually include only one plate of the skull.

The External Surface of the Skull

The external surface may be divided into **superior** or **vertex, inferior,** or **base, anterior,** or **face,** and **lateral regions.**

The **superior region,** or **vertex,** extends from the supraorbital margins to the superior curved line of the occiput, bounded laterally by the temporal lines. It is a smooth, convex surface covered by muscle and aponeurosis. The greatest transverse diameter of the skull is at the junction of the posterior and middle thirds, viz., $5\frac{3}{5}$ inches (140 mm.); the greatest longitudinal diameter from the under margin of the frontal bone to the external occipital protuberance is $6\frac{4}{5}$ inches (170 mm.).

The **anterior region,** or **face,** presents the openings of the orbits, the bridge of the nose, below that the *anterior nasal aperture* (*apertura pyriformis*), presenting the anterior nasal spine below. Below the aperture are the incisor fossæ of the upper jaw, below the orbits the canine fossæ, and external to them the malar prominences. The lower jaw completes the skeleton of the face with its incisor fossæ, mental prominence, etc.

In a nearly vertical line on either side are three foramina for the exit of some part of the three divisions of the fifth cranial nerve, viz., the supraörbital, infraorbital, and mental. There are also the malar foramina on the malar bone.

The **orbits** are pyramidal fossæ, somewhat quadrihedral, with their bases turned forward and out; their inner walls are nearly parallel, and their outer walls diverge at nearly right angles to each other. Each is formed of seven bones, or eleven for the two—the frontal, sphenoid, malar, superior maxillary, lacrymal, ethmoid, and palate. The *roof* of each is formed by the orbital plate of the frontal and small wing of the sphenoid; the *floor* by the malar, superior maxilla, and orbital plate of the palate; the *inner wall* by the nasal process of the superior maxilla, the lacrymal, ethmoid, and body of the sphenoid; the *outer wall* by the malar and great wing of the sphenoid. The *sphenoidal fissure* at its inner part occupies the apex of the orbit; its outer extremity lies between the roof and outer wall.

The *optic foramen* is internal to and above the fissure. In the angle between the external wall and floor is the *spheno-maxillary fissure*, bounded by the palate, superior maxilla, malar, and sphenoid bones; it leads into the sphenomaxillary fossa at its back part and the zygomatic fossa at its forepart. Passing forward from the margin of this fissure is the commencement of the infraorbital canal. On the inner wall in front is the lacrymal groove, leading to the canal of the nasal duct, and farther back, between the frontal and ethmoid, are the *anterior* and *posterior internal orbital* or *ethmoidal canals.* At the junction of the inner and middle thirds of the anterior margin of the roof is the supraorbital foramen or notch. Within the external angular process is the *lacrymal fossa,* and on the outer wall are the temporal and malar canals.

The **lateral region of the skull** presents from behind forward the mastoid portion, the mastoid foramen, the external auditory meatus, the glenoid fossa with the condyle of the lower jaw, eminentia articularis, coronoid process, and *zygomatic arch.* Above this arch is the *temporal fossa,* and below it, separated by the infratemporal crest, is the *zygomatic fossa.*

The *temporal fossa,* occupied by the temporal muscle, is bounded above by the temporal crest of the frontal and the lower temporal line of the parietal; the latter runs into the supramastoid crest, and that into the zygomatic arch.

The *zygomatic* or *infratemporal fossa* contains a part of the temporal muscle, the external and internal pterygoids, the internal maxillary artery, and the inferior maxillary nerve. Some of its boundaries are indefinite; externally is the ramus of the lower jaw; superiorly the great wing of the sphenoid, showing the foramen ovale and spinosum, also a small part of the squamous portion of the temporal; anteriorly is the lower part of the malar and zygomatic surface of the superior maxilla; the inferior limit is the extremity of the external pterygoid plate and alveolar border of the superior maxilla. The inner wall is formed by the external pterygoid plate; the posterior limit is the eminentia articularis and posterior border of the external pterygoid plate.

Inferiorly the pterygoid process approaches close to the superior maxilla, but is prevented from meeting by the pyramidal process of the palate. Above they are separated by the *pterygomaxillary fissure,* leading into the *sphenomaxillary* *fossa.* Running at right angles to the fissure is the sphenomaxillary fissure opening into the orbit.

The **sphenomaxillary fossa** is a small triangular space at the angle of junction of the above-named fissures, placed beneath the apex of the orbit. It is bounded above by the body of the sphenoid, in front by the superior maxilla, behind by the base of the pterygoid, and internally by the vertical plate of the palate. It has three fissures terminating in it—the sphenoidal, sphenomaxillary, and pterygomaxillary. It communicates with four fossæ—the orbital, nasal, zygomatic, and middle fossa of the base of the skull; and has opening into it five foramina—three from behind, the foramen rotundum, the Vidian, and the pterygopalatine canals; internally is the sphenopalatine foramen, and inferiorly the posterior palatine canals, and occasionally the accessory posterior palatine canals.

The **external base of the skull** ("base of skull" properly means base of the cranium, and does not include the facial bones; the usual description, however, will be followed, and the inferior maxilla included) is divisible into three parts—anterior, middle, and posterior. The *anterior division* consists of the palate, alveolar arches, and body of the inferior maxilla. It is traversed longitudinally by a median suture, and transversely by that between the maxillary and palate bones. In front is the *anterior palatine fossa,* with the four foramina opening into it; farther back are the under surface of the tuberosity of the palate, the apertures of the posterior and external palatine canals, and the posterior nasal spine.

The *middle division* extends back to the foramen magnum, and is called the *guttural fossæ* (relating to the throat). In the midline is the basilar process, and in front of that the body of the sphenoid covered by the alæ of the vomer. On each side the petrous portion reaches to the extremity of the basilar process, and between the petrous and squamous is the back part of the great wing of the sphenoid. In front are the *posterior nares,* or *choanæ* (funnels), separated by the vomer, bounded above by the sphenoid, below by the horizontal plates of the palate bones, and laterally by the internal pterygoid plates. On each side are the pterygopalatine and Vidian canals, the scaphoid and pterygoid fossæ. A line from the external pterygoid plate to the spine of the sphenoid separates this surface from the zygomatic fossa; internal to this line is the groove for the cartilaginous part of the Eustachian tube. Between the apex of the petrous, the basilar process, and the sphenoid is the *foramen lacerum* (this is the only foramen properly called "lacerated"). This with the petrobasilar fissure is filled with fibrous tissue, and may contain Wormian bones. Passing back and out from this is the petrosphenoidal fissure, the styloid and vaginal processes, and the stylomastoid foramen; more internally are the anterior condylar foramina and the jugular fossa. This fossa is divided into three compartments by processes of the dura mater. The inferior petrosal sinus is in the anterior one, the lateral sinus, some ascending pharyngeal and occipital arteries in the posterior one, and the ninth, tenth, and eleventh cranial nerves in the middle one.

Other points have been described with the temporal bone.

The *posterior division* presents on either side of the foramen magnum the occipital condyle, jugular process, occipital sulcus, digastric fossa, and mastoid process. Behind the foramen magnum is the tabular part of the occipital up to the superior curved line. Into this posterior division are inserted all the muscles running up to the skull from the ribs, spines, and transverse processes.

The Interior of the Cranium

The interior of the cranium presents impressions for the cerebral convolutions. The thickness of the skull-cap, or *calvaria*, is $\frac{1}{6}$ to $\frac{1}{4}$ inch. The base of the skull varies in thickness, thinnest at the cribriform and orbital plates, where there is no diploë; also thin in the inferior occipital fossa, in the squama, and glenoid fossa. The inner surface of the calvaria is dome-like, formed by the frontal, parietal, and occipital bones. It is marked by the superior longitudinal sulcus, small meningeal grooves, and Pacchionian fossæ. The only apertures are the inconstant parietal foramina.

The Internal Base of the Skull

This surface is divided into three fossæ—anterior, middle, and posterior.

The **anterior fossa** is formed by the orbital plates of the frontal, the cribriform of the ethmoid, the small wings and part of the body of the sphenoid; it supports the frontal lobes of the cerebrum. It is convex laterally, with a slight concavity over the cribriform plate excepting where the crista galli stands up separating the olfactory grooves. Here are found the foramen cecum, the olfactory foramina, openings of the internal orbital or ethmoidal canals, and the foramen for the nasal nerve.

The **middle fossa** is on a lower level than the anterior, and consists of a median and two lateral parts. The median part is narrow, presenting the olivary eminence, the sella Turcica, and limited behind by the dorsum sellæ. Laterally is the great wing of the sphenoid, the squama, and anterointernal surface of the petrous portion. This lodges the temporal lobe of the cerebrum. The foramina present are the optic, sphenoidal fissure, foramen rotundum, ovale, spinosum, lacerum, and hiatus Fallopii.

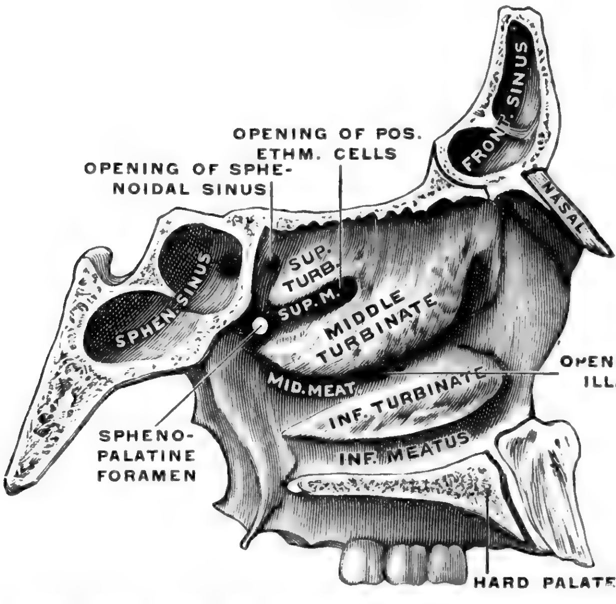
The **posterior fossa** is deeper and larger than the others, and lodges the cerebellum, medulla, and pons. The occipital bone, the petrous and mastoid portions of the temporal, postero-inferior angle of the parietal, and body of the sphenoid enter into it. In the centre is the foramen magnum, and on each side, in a nearly vertical line, are the anterior condylar foramen, jugular foramen, and internal auditory meatus. Behind the jugular foramen is the posterior condylar (if present), and higher up the mastoid foramen, both opening into the lateral sulcus. By the internal auditory meatus the facial and auditory nerves, the portio intermedia, and the auditory vessels leave the cranium.

Besides these points mentioned there are grooves for arteries and venous sinuses.

That for the middle meningeal artery commences at the foramen spinosum, and passes anteriorly to the great wing of the sphenoid, and posteriorly upon the squama and parietal. There is also the groove for the internal carotid artery on the side of the body of the sphenoid, the groove for the superior longitudinal sinus terminating at the internal occipital protuberance, those for the lateral sinuses, and others for the superior and inferior petrosal sinuses on the petrous portion.

The **nasal cavities,** or the **nasal fossæ,** are placed one on each side of a median vertical septum. They open in front by the anterior nasal aperture and behind by the posterior nares. They communicate with the sinuses of the frontal, ethmoid, sphenoid, and superior maxillary bones. They are narrow transversely, especially above. The *internal wall*, or *septum nasi*, is formed by the perpendicular plate of the ethmoid, the vomer, nasal spine of the frontal, crests of the nasal, rostrum of the sphenoid, crests of the maxillary, and palate bones. There is an angular deficiency in front, filled by the septal cartilage, which usually deviates to one side.

Fig. 12



The left nasal fossa, viewed from the middle line, showing the three meatuses. (Testut.)

The *roof* is horizontal in the middle part and sloping in front and behind. The middle part is formed by the cribriform plate of the ethmoid, the forepart by the nasal and frontal bones, the back part by the body of the sphenoid, the ala of the vomer, and sphenoidal process of the palate. In the angle formed by the cribriform plate and body of the sphenoid is the *sphenoethmoidal recess;* the sphenoidal sinus opens upon its posterior wall.

The *floor* is formed by the palate processes of the maxillary and palate bones; it is smooth and concave transversely, and shows the orifice of the incisor foramen. The *external wall* is formed by the nasal, superior maxillary, lacrymal, ethmoid, inferior turbinate, palate, and internal pterygoid plate of the sphenoid. The superior and inferior turbinate processes of the ethmoid and the inferior spongy bone overhang the three meatuses. The *superior meatus* is very short, and placed between the superior and inferior turbinate processes; into it open in front the posterior ethmoidal cells, and behind the sphenopalatine foramen. The *middle meatus* is above the inferior spongy bone, and communicates with the anterior and middle ethmoidal cells, with the maxillary sinus or antrum, and in front by the infundibulum with the frontal sinus. The *inferior meatus,* longer than the others, lies between the inferior spongy bone and the floor of the cavity; in front is the orifice of the nasal duct.

The **air sinuses** communicate with the basal cavities by narrow orifices; with the exception of the maxillary sinus (antrum) they are not present at birth. In old age they increase in size by absorption of neighboring cancellated tissue. The antrum begins to be formed about the fourth month. The frontal, ethmoidal, and sphenoidal excavate their respective bones in childhood, and at puberty undergo a great enlargement. Their purpose may be for resonance. They have been sufficiently described with the different bones.

THE THORAX

The Thorax as a Whole

The *bony thorax* is conical, and flattened from before backward. The short anteroposterior diameter is characteristic of man, but in the lower mammals and human fetus it is longer than the transverse diameter. The posterior wall is convex forward, and a broad furrow on either side, the *sulcus pulmonalis,* is formed by the ribs as they project backward, so that the weight of the body is more equally distributed around the column. The anterior wall is convex and at an angle of 20 to 25 degrees with the posterior. A horizontal anteroposterior diameter from the base of the ensiform is 8 inches (20 cm.); the transverse at the eighth or ninth rib is 11 inches (28 cm.); the vertical anteriorly is 6 inches (15.5 cm.), and posteriorly is 12 inches (31.5 cm.). The upper border of the sternum is opposite the lower edge of the second dorsal (Henle), and the lower border opposite the tenth dorsal. The sides slope out to the ninth rib. The upper aperture is contracted and reniform, and sloped downward; the lower is irregular, and its margin ascends on each side from the tenth rib to the ensiform, forming the *subcostal angle.* The intercostal spaces are wider above than below.

The skeleton of the thorax comprises the dorsal vertebræ, the sternum, ribs, and costal cartilages.

The dorsal vertebræ have been described.

The Sternum

The *sternum* is an azygos bone in the median line at the front of the chest. It has attached the clavicles and seven upper costal cartilages. It originally consisted of six segments, and is likened to a sword. The upper segment remains distinct as the *manubrium,* or *handle;* the next four fuse into the *body,* or *gladiolus* (little sword); the sixth portion is the *ensiform* or *xiphoid process* (sword-like).

The sternum is flattened from before backward, and curved, with a slight convexity, to the front. It is broad above, narrower where the two upper segments meet, then broad again, and narrow at the ensiform.

The **manubrium** is the thickest part. It presents two surfaces, an anterior and a posterior, which are roughly quadrilateral. The *anterior surface* is convex from side to side, and concave from above downward. It gives attachment, on each side, to a portion of the pectoralis major aponeurosis, and the sternal portion of the sternocleidomastoid muscle. The *posterior surface* is concave and smooth. It gives attachment to the sternohyoid and sternothyroid muscles of each side.

Superiorly are three deep notches; the middle one is the *semilunar* or *interclavicular* notch; the lateral ones look up, back, and out for articulation with the clavicles. Below the lateral notches on either side is a rough triangular surface for union with the first costal cartilage; next is a sloping concave surface; and at the lower angle a half-notch for the second rib. The junction of the manubrium with the gladiolus is always prominent, and serves as a landmark for the second rib.

The **body** is longer, narrower, and thinner than the manubrium, and tapers toward its lower end. It is marked on its *anterior* surface by three slight transverse ridges; otherwise it is quite flat. This surface gives attachment to a part of the aponeurosis of the pectoralis major of each side. The *posterior surface* is slightly concave and marked by the same lines as anteriorly, but less distinctly, and gives attachment below to the triangularis sterni of each side.

Each lateral margin presents four notches and two half-notches; they approach each other from above down, being separated by curved intervals. The half-notch above is for the second cartilage; the notches for the third, fourth, and fifth cartilages are opposite the line of junction of the four segments; the notch for the sixth cartilage and the half-notch for the seventh belong to the inferior segment. So most of the cartilages of the true ribs articulate in front at junctions of segments, analogous to the connection of ribs with the vertebral column.

The **ensiform process** (**metasternum**) projects down between the cartilages of the seventh rib. It has various forms, is usually more or less triangular, and may be bent forward, backward, or laterally, be forked or perforated, and is cartilaginous during youth. At its upper angle is a half-notch for the seventh cartilage.

Its *anterior surface* has attached the chondroxiphoid ligaments. Its *posterior surface* gives attachment to some fibers of the diaphragm and triangularis sterni muscles. Its lateral borders afford attachment to parts of the aponeurosis of the abdominal muscles. To the apex is inserted the upper end of the linea alba.

THE RIBS

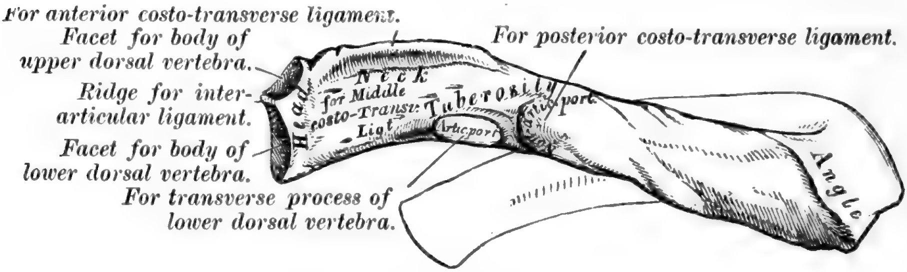
The **ribs** (**costæ**) are twelve in number on each side. They are obliquely placed, running forward and downward. The obliquity increases from above downward to the ninth rib, where it reaches its maximum; from there downward it decreases.

The first seven pairs, attached by costal cartilages to the sternum, are called *sternal, true,* or *vertebrosternal* ribs; the remaining five pairs are *asternal* or *false* ribs; each of the upper three pairs of false ribs has its cartilage attached to the cartilage above it, *vertebrochondral;* the last two pairs have no such attachment, and are *floating* or *vertebral* ribs.

Each rib presents three parts—a body, an anterior and a posterior extremity.

The *posterior extremity* presents for examination a head, a neck, and a tuberosity. The head is thickened and rough; it has a superior and an inferior articular facet for articulation with two vertebræ; the lower is the larger; between them is a ridge for the attachment of the interarticular ligament.

Fig. 13



Vertebral extremity of a rib; external surface. (Gray.)

Next externally is the flattened *neck,* about an inch long, situated in front and above the transverse process of the lower of the two vertebræ the head articulates with. It presents an anterior and a posterior surface, a superior and an inferior border. The *anterior surface* is flat and smooth, the *posterior* rough for the attachment of the middle costotransverse ligament. The *superior border* presents a rough ridge for the attachment of the anterior costotransverse ligament. The *inferior border* is rounded and free. On the lower part of the posterior aspect of the junction of the neck and shaft is an eminence, the *tuberosity,* most prominent in the upper ribs. It is divided into two parts by an oblique groove. The inner and lower part is articular for the transverse process of the lower of the two vertebræ, with which the rib is connected; the outer and upper part is rough for the posterior costotransverse ligament.

The *body* is laterally compressed, presenting two flat surfaces, external and internal, and two borders, superior and inferior. On the *external surface*, close in front of the tuberosity, over the most convex portion of the rib, is found an oblique rough line, directed downward and outward, corresponding to the outer border of the iliocostalis muscle, marking the *angle*. The interval separating the tuberosity and the angle increases from the second to the tenth rib. The *anterior angle* is found near the sternal end of this surface.

The *internal surface* is smooth, concave, directed slightly upward behind the angle, and slightly downward in front of it.

The *superior border* is thick and rounded, and presents an external and an internal lip, for the attachment of the external and internal intercostal muscles.

The *inferior border* presents the subcostal groove, best marked at the angle disappearing in front. Its external lip is much the more prominent, and gives attachment to the external intercostal muscle. The inner or superior lip of this groove is rounded and gives attachment to the internal intercostal. The groove itself lodges the intercostal vessels and nerve.

Starting from the upper and inner border of the neck is a superior costal groove, soon lost on the body.

The *anterior extremity* is hollowed into a pit for union with the costal cartilage. The ribs are curved on three axes—a vertical one near the angle; also a transverse one at this place, so that when the anterior part of the rib is horizontal the posterior will rise up; and a longitudinal one, so that the anterior part looks up and the posterior part looks down.

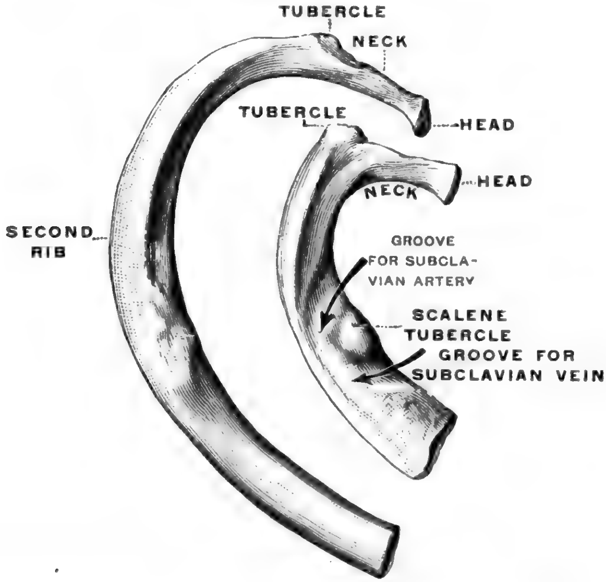
The seventh or eighth rib is the longest, after which the ribs decrease to the twelfth. The first is broadest, and the twelfth narrowest.

The Peculiar Ribs

The peculiar ribs are first, second, tenth, eleventh, and twelfth.

The **first rib** is short and not twisted, yet one of the most curved. Its surfaces look nearly up and down. The *head* is small and has a single articular facet. The *neck* is slender and rounded, and the *angle* coincides with the tuberosity, which is strong and placed on the outer margin of the rib. At this point there is a slight bend in the rib, with the convexity upward. On the upper surface, close in front of the tuberosity, is a rough impression for the scalenus medius muscle, and in front of that two smooth depressions with an intervening ridge; the posterior depression is for the "third portion" of the subclavian artery, the ridge ending in the *scalene tubercle* (Lisfranc's tubercle) is for the attachment of the scalenus anticus muscle, and the anterior depression for the subclavian vein. This surface about its middle also gives attachment to a part of the serratus magnus. The *under surface* is smooth. There is no subcostal groove.

Fig. 14



The first and second ribs of the right side, viewed from above. (Testut.)

The **second rib** is not twisted and has no angle (Henle); it presents near its middle, impressions for the scalenus posticus and two serrations of the serratus magnus muscles. Its head presents a double articular facet.

The **tenth rib** may have but one articular facet.

The **eleventh** and **twelfth ribs** are short, have single articular facets, and only slight elevations to mark the tuberosities which do not articulate with the transverse process. They are pointed at their anterior extremities.

The **eleventh** has a slight subcostal groove; the **twelfth** has no angle.

The **number of ribs** may be thirteen on one or both sides. The added rib is most often connected with the first lumbar transverse process, sometimes with the seventh cervical vertebra, where it has a double attachment, viz., to the body and to the transverse process. The twelfth rib varies in length from 8 inches to less than 1 inch.

The Costal Cartilages

The costal cartilages prolong the ribs to the sternum. Their breadth diminishes from the first to the last; they become narrow toward their sternal extremities; their length increases to the seventh; the first descends a little, the second is horizontal, the others, except the last two, ascend after following the direction of the rib for a short distance. Their external extremities are convex, and planted into the osseous tissue of corresponding ribs. The inner extremity of the first is united directly to the sternum without articular cavity; the succeeding six have rounded extremities for the sternal notches. Each cartilage of the first three false ribs is united to the lower border of the one above it. The fifth, sixth, seventh, and eighth cartilages articulate with each other; the eleventh and twelfth are pointed and unattached.

They give partial attachment to the diaphragm, internal abdominal, oblique, transversalis, rectus, triangularis sterni, internal intercostals, pectoralis major, subclavian, and sterno-thyroid muscles.

The eighth may articulate with the sternum. The seventh may meet its fellow of the other side in front of the ensiform. There may be no articulation between the fifth and sixth; there may be one between the eighth and ninth.

THE BONES OF THE UPPER EXTREMITY

Upper limb:
- Shoulder { clavicle, scapula }, forming shoulder girdle.
- Arm (brachium), humerus.
- Forearm (antebrachium), radius and ulna.
- Hand (manus) { carpus. metacarpus. phalanges. }

THE BONES OF THE SHOULDER GIRDLE

The Clavicle

The clavicle (key) passes out, back, and slightly upward from the summit of the sternum to the acromion, and connects the upper limb to the trunk. It is curved like the letter *f*. The inner curve is convex forward, and occupies two-thirds of the bone; this part is prismatic. The outer third of the bone is concave in front, and is flattened from above down.

The superior surfaces of these two portions are continuous; the inferior surfaces are continuous; the anterior border of the outer portion runs into the anterior surface of the inner; and the posterior border of the outer is continuous with the posterior surface of the inner.

The *superior surface* is broad externally and largely subcutaneous; at its centre it may present a canal for the supraclavicular nerve; the sternocleidomastoid is attached to the inner part. The *anterior surface* is reduced to a rough border on the outer third, where it gives attachment to the deltoid, and may present a *deltoid tubercle.* The pectoralis major is attached to the inner half.

The *posterior surface* is a border externally to one-third the extent of the bone, and gives attachment to the trapezius. In the middle of this surface is the orifice of a medullary canal directed outward. (In bones having but one secondary centre the medullary artery runs *from* it.) Internally close to the sternal end this surface gives attachment to a part of the sternohyoid muscle.

The *inferior surface* is narrow at its sternal end, widening out to the full width of the bone in its outer third. It shows internally a rough impression or *costal tuberosity* about 1 inch long, for the rhomboid ligament; internal to it is a small facet for articulation with the cartilage of the first rib; external to it, a groove passing beyond the middle third for the subclavius muscle; the groove may show a longitudinal ridge for an intermuscular septum. On the posterior border, at the junction of the outer and middle thirds, is the *conoid tubercle* (scapular tuberosity), and passing out and forward from it the *trapezoid line*.

The *sternal end* is thick and projects in an angle downward and backward, its triangular concavoconvex surface looking a little downward and forward. The *scapular end* is so bevelled as to rest upon the acromion, the small articular surface looking down and out; this end is normally a little higher than the acromion on which it rests.

The Scapula

The scapula is a large triangular flat bone, situated at the posterior and lateral aspect of the chest, between the second and seventh ribs of the seventh interspace. Its *posterior border* is about 1 inch from and parallel with the vertebral spines. It is attached to the trunk by the clavicle and by muscles, and from it is suspended the humerus.

The bone consists of a large triangular blade or *body*, and two processes, the coracoid and spine, and presents for examination two surfaces, three borders, and three angles. The *anterior surface*, or *venter*, looks forward, downward, and inward, and presents the *subscapular fossa*, marked by three or four converging oblique lines, giving attachment to tendinous intersections of the subscapular muscle. The deepest part of the fossa is the *subscapular angle*, where the bone seems bent on itself, so that the thickest part of the muscle is perpendicular to the plane of the glenoid cavity, and can act most advantageously. Separated from this fossa are two flat surfaces, one at the upper angle and one at the lower; with the line connecting them close to the vertebral border they give attachment to the serratus magnus muscle.

The *posterior surface*, or *dorsum*, is divided by the spine into two unequal fossæ, the *supraspinous* and *infraspinous*. The supraspinous is less than half the size of the infraspinous fossa. It is smooth, concave, and broader at its vertebral than at its humeral end, and gives origin by its inner two-thirds to the supraspinatus muscle.

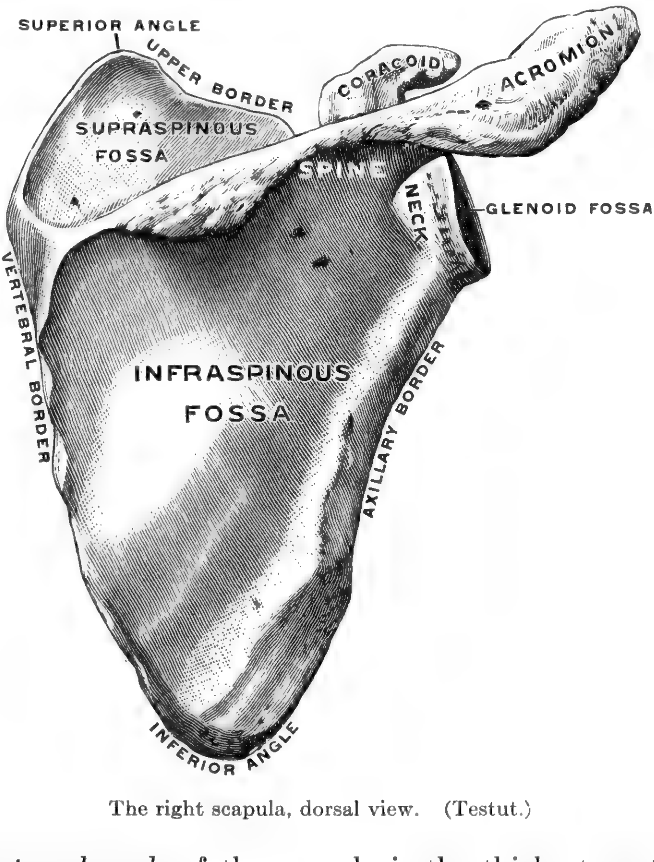
The lower fossa is marked near the centre by a convexity corresponding to the concavity of the venter; on either side of this is a groove, the external one being deep and bounded by the axillary border. Near the inner border are short lines for intermuscular septa of the infraspinatus muscle, which rises from the inner two-thirds and covers the outer third. Along the outer part of this surface is a ridge passing down and back to the inner border, about 1 inch above the inferior angle; it gives attachment to the aponeurosis between the infraspinatus and teres muscles. On the upper third of the narrow surface between this line and the axillary border is a groove for the dorsalis scapulæ vessels; the middle third and part of the upper give attachment to the teres minor. Below this, including the inferior angle, is a raised surface for the teres major, over which the latissimus dorsi glides or attaches a small fasciculus. An oblique line separates the origins of the two teres muscles.

The *spine* of the scapula is a triangular plate projecting back and up from the dorsum. Beginning near the upper fourth of the vertebral border, it passes out across the dorsum to the middle of the neck of the scapula, and turns forward into the *acromion process.* The upper and lower surfaces are concave and form parts of the two dorsal fossæ. It has two unattached borders, a posterior subcutaneous one and an external axillary one. The former rises from the vertebral border by a triangular surface, over which a tendon of the trapezius glides as it passes to its insertion into a rough tubercle beyond. The rest of this border is rough and serpentine, and gives attachment by a superior lip to the trapezius, by an inferior lip to the deltoid. The external border is short, smooth, and concave, enclosing the *great scapular notch.*

The *acromion process* projects out and forward over the glenoid fossa; it is compressed from above down; its superior surface is rough, subcutaneous, and continuous with the prominent border of the spine. Anteriorly, on its inner border, is an oval articular facet for the clavicle; to this border is attached the trapezius, to the outer border the deltoid, marked by three or four tubercles for tendinous septa. This outer border terminates posteriorly in the *acromial angle.* The coracoacromial ligament is attached to the apex of the acromion.

The *coracoid process* rises at first almost vertically from the upper border of the head, compressed from before backward; it then bends at a right angle forward and outward, and is compressed from above downward. Superiorly, toward its base, is the origin of the conoid ligament, and the trapezoid rises from an oblique line running forward and outward from attachment of the conoid ligament on the superior surface. The coracoacromial ligament is attached to the outer border, the conjoined tendon of the coracobrachialis and biceps to its apex, and the pectoralis minor to its inner border and adjacent part of the superior surface. The tip of the coracoid is about one and one-half inches distant from the apex of the acromion.

FIG. 15



The right scapula, dorsal view. (Testut.)

The *external angle* of the scapula is the thickest part of the bone; it is called the *head,* supported on a *neck.* The head bears the *glenoid cavity;* this is slightly concave, looks outward, forward, and slightly upward. It is pyriform, with its narrow end above, and measures $1\frac{3}{5}$ inches by $1\frac{1}{5}$ inches (40 mm. by 30 mm.). Above it is a *supraglenoid tubercle* for the long head of the biceps. The "anatomical neck" is the part just behind the head.

The *superior angle* of the scapula is thin and rounded, and gives attachment to some fibers of the levator anguli scapulæ.

The *inferior angle* is thick and rough posteriorly for the teres major attachment, sometimes the latissimus dorsi.

The *superior border* is shortest, and extends from the superior angle down to the coracoid, at the base of which is the *suprascapular* or *coracoscapular notch.*

The *axillary border* is the thickest. Beneath the glenoid fossa is a rough tubercle or ridge, *infraglenoid,* over an inch long, for the long head of the triceps. On the ventral aspect of this border is a longitudinal groove, from the lower part of which the subscapular muscle rises in part.

The *vertebral border* is the longest, and gives attachment above the triangular surface at the apex of the spine to the levator anguli muscle, opposite the triangular surface to the rhomboideus minor, and below this to the rhomboideus major.

THE BONE OF THE ARM

The Humerus

The arm bone extends from the shoulder to the elbow. It is divisible into an upper extremity, including head, neck, great and small tuberosities, a shaft, and inferior extremity, which includes condyles, epicondyles, and articular surface. The *head* forms one-third of a sphere, but the margin is not a true circle. The head is directed up, in, and a little backward, and makes an angle of 140 degrees with the shaft. The "anatomical neck" is the slight constriction at the circumference of the articular surface; the "surgical neck" is below the tuberosities.

The *great tuberosity* is a thick projection starting up from the external surface of the shaft. It is marked above by three facets, the upper for the supraspinatus tendon, the next for the infraspinatus, and the lowest for the teres minor, which also is attached to the shaft to the extent of 1 inch. Internally separated from this tuberosity by the *bicipital groove* (intertubercular sulcus) is the *small tuberosity,* looking forward and inward and giving attachment to the subscapularis.

The *shaft* is thick and cylindrical above, expanded transversely and three-sided below. It is divided into external, internal, and posterior surfaces by anterior and lateral borders. Superiorly is the bicipital groove lodging the long tendon of the biceps and a branch of the anterior circumflex artery. This groove, descending, is bounded by rough margins, the external or *pectoral ridge* for the pectoralis major muscle, and the internal for the latissimus dorsi and teres major muscles. These muscular attachments end at the junction of the upper fourth with the lower three-fourths.

The *anterior border* is the pectoral ridge continued to the coronoid depression below. It becomes rounded and smooth below, and gives attachment to the brachialis anticus muscle.

The *inner border* is the inner bicipital ridge continued to the inner condyle, called below the *internal supracondylar ridge.* About the centre of this border is a rough linear mark for the coracobrachialis muscle, and just below it the orifice of the medullary canal directed downward.

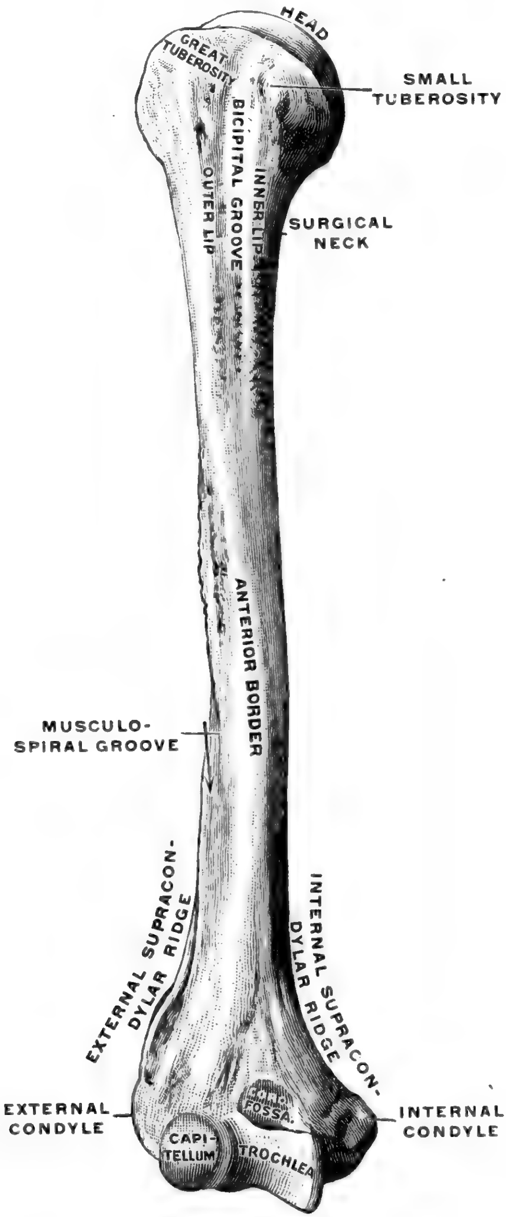
The *external border* runs from the back part of the great tuberosity to the external condyle. Its centre is traversed by a broad *spiral groove,* which is limited above by the *deltoid eminence* and below by the *external supracondylar ridge.* This ridge gives origin by its upper two-thirds to the supinator longus muscle; hence it is called the *supinator ridge,* which is very large in burrowing animals; its lower third attaches the extensor carpi radialis longior. The posterior lip of either supracondylar ridge is for the triceps, and a middle portion for intermuscular septa. The *external surface* presents near its middle the *deltoid eminence;* above this it is smooth and rounded; below it, it is smooth and looks outward and forward, giving attachment to a part of the brachialis anticus.

The *internal surface* is narrow above, and forms the bicipital groove; near its centre is the insertion of the coracobrachialis. Below this level it is smooth, looks inward and forward, and gives attachment to parts of the brachialis anticus.

The *posterior surface* is twisted, so that its upper part is directed a little inward, its lower part backward and outward. It is nearly all covered by the external and internal heads of the triceps, which are separated by the spiral groove running down and out. At the upper part of this groove is generally a second medullary foramen for a branch of the superior profunda artery.

The *inferior extremity* is flattened from before backward and curved slightly forward. The two *condyles* include the

Fig. 16



The right humerus, front view. (Testut.)

articular surface, separated by a rounded ridge; the inner condyle is five-sixths articular. The prominent tuberosities situated on either condyle are the *epicondyles,* developed from separate centres. The *internal epicondyle* is the more prominent one, is inclined backward, and forms posteriorly a shallow groove for the ulnar nerve. It gives attachment to the pronator radii teres and the common tendon of the superficial pronatoflexor muscles of the forearm.

The *external condyle* presents (1) the epicondyle, which gives origin to some of the supinatoextensor muscles of the forearm; (2) below and internal to this on the condyle a small impression for the anconeus; and (3) a pit for the external lateral ligament.

The *inferior articular surface* is divided into two parts: The external part, rounded and directed forward, is the *capitellum* for articulation with the radius; it does not extend at all on the posterior surface. Internal to it is a groove for the inner margin of the head of the radius. The internal portion, or *trochlea,* articulates with the ulna, and extends upon the anterior and the posterior surface of the bone; the external border is rounded and corresponds to the interval between the radius and ulna. The internal border is thick and prominent. Anteriorly these margins are inclined down and inward, posteriorly up and outward, so that the groove is obliquely inclined from without inward, and if continued would form the thread of a screw. The external part of the trochlea is the segment of a sphere, the internal part the segment of a truncated cone with base internal; at the junction of the cone and sphere is the groove.

Above the trochlea posteriorly is the *olecranon fossa,* above it anteriorly the *coronoid fossa;* the thin plate between them may be perforated by the *supratrochlear foramen.* This occurs more often in the lower races of man. Above the capitellum is the *radial fossa* for the head of the radius in flexion.

The average length of the adult male humerus is 13 inches; female, 12 inches. It is nearly one-fifth the height of the individual. The right humerus with the radius is usually $\frac{1}{3}$ to $\frac{3}{4}$ inch longer than the left; but there is no difference at birth.

The shaft of the humerus is twisted through about 135 degrees. The twist is seen at the spiral groove, "groove of torsion," which does not exist in the fetus; this allows the hand to serve the purposes of the head and mouth. A small hooked *supracondylar process* is sometimes found about two inches above the inner epicondyle.

THE BONES OF THE FOREARM

The Ulna

This is the internal of the two bones of the forearm. It articulates with the humerus, radius, and the triangular articulo-cartilage at the wrist. It presents for examination a shaft and two extremities.

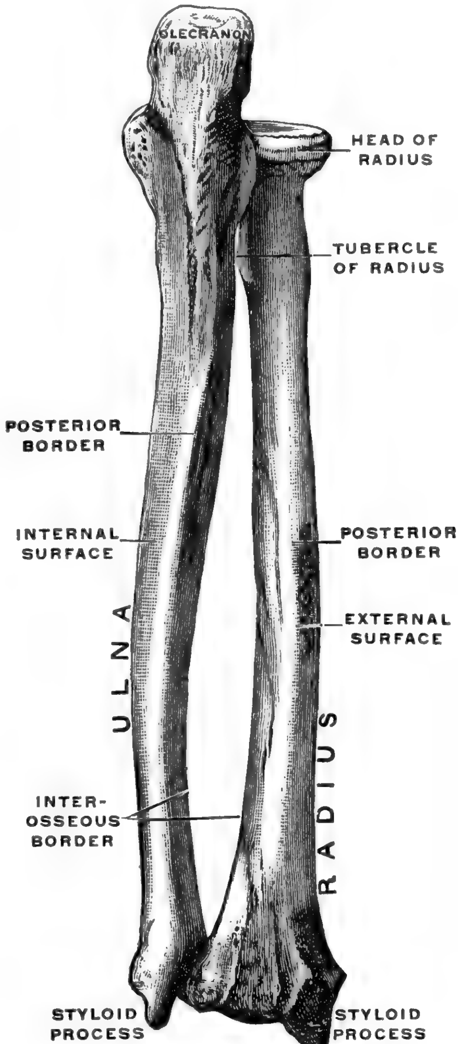
The *upper extremity* presents two processes and two articular concavities.

The *olecranon* process forms the uppermost part of the ulna. It terminates superiorly in front in a beak which overhangs the great sigmoid cavity; behind this is a rectangular tuberosity, forming the point of the elbow. It has superiorly a quadrilateral surface, transversely grooved in front for attachment of the posterior ligament of the elbow; behind this it gives attachment to the triceps. The posterior surface of the olecranon is triangular and subcutaneous, covered by a bursa, and continuous with the posterior border of the ulna.

The lateral surfaces show anteriorly continuations of the groove just mentioned, the inner for the posterior portion of the internal lateral and the external for part of the posterior ligament of the elbow. Internally there is also attached a portion of the flexor carpi ulnaris; externally the anconeus. The *anterior surface* is smooth, curved forward above, and forms the upper and part of the greater sigmoid cavity. The *inferior surface,* or base, is attached to the shaft.

The *coronoid process* is a rough triangular eminence projecting forward from the anterior aspect of the ulna just below the olecranon. Its *base* is large and firmly united to the shaft. Its upper surface is smooth, concave, forming the inferior portion of the greater sigmoid cavity and the lowest part of the back of that cavity. Its apex is bluntly pointed, and curved slightly upward. The under surface is rough, concave, looking downward and outward. At the junction of this surface with the shaft and extending a short distance down on the shaft is a rough eminence, the tubercle of the

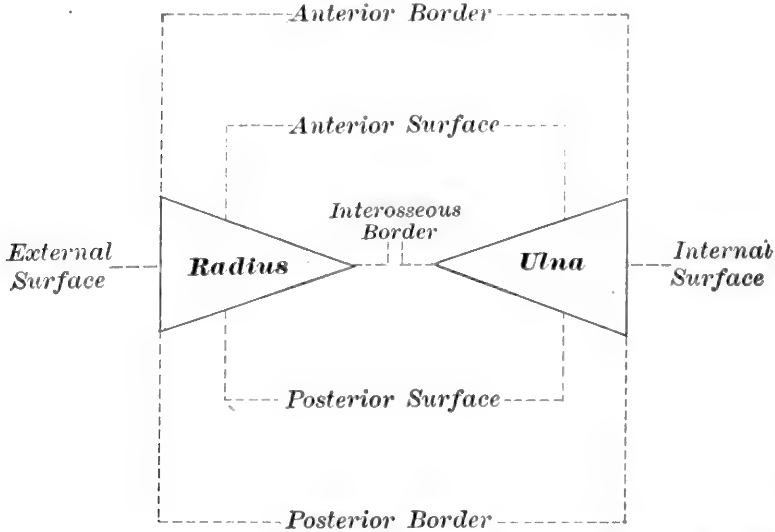
Fig. 17



The bones of the right forearm, rear view. (Testut.)

ulna, for attachment of the upper end of the oblique ligament and part of the brachialis anticus; the main part of this muscle is attached to the inner part of the junction of the coronoid and shaft. Its *external surface* presents the lesser sigmoid cavity, and just below it a small area giving attachment to a part of the supinator brevis. The *inner surface* is slightly concave, and bounded in front by a prominent margin, terminating above in a rounded eminence. To the eminence one head of the flexor sublimis digitorum is attached, to the ridge the deep head of the pronator radii teres, and on the surface itself one portion of the flexor profundus digitorum finds origin. Often a fasciculus of the flexor longus pollicis arises from the lower part of this surface.

FIG. 18



Showing a transverse section of the radius and ulna and indicating their borders and surfaces.

The *great sigmoid cavity,* articulating with the trochlea, looks upward and forward, and is bounded above by the *olecranon* and below by the *coronoid processes;* it is concave from above down, and is traversed by a longitudinal ridge, which is a half-circle.

A slight constriction is seen across the middle of the cavity. The part external to the ridge is broad and convex above the constriction, concave in its other subdivisions.

Continuous with this cavity is the *small sigmoid cavity* on the outer side of the base of the coronoid; it is concave from before backward, with its long axis in the same direction, for the head of the radius.

The *shaft*, or *body*, tapers from above, is three-sided in its upper three-fourths, slender and cylindrical in its lower fourth. The upper three-fourths is convex backward; it is also convex externally above and internally below. The *anterior border* passes from the inner edge of the coronoid to the front of the styloid; it is thick and rounded, and gives attachment to the flexor profundus digitorum, and in the lower fourth to the pronator quadratus.

The *posterior border* begins below the olecranon, and runs with a sinuous curve to the back of the styloid. It is ill defined below and subcutaneous throughout, and affords attachment to an aponeurosis common to three muscles—the flexor carpi ulnaris, extensor carpi ulnaris, and flexor profundus. The *external* or *interosseous* border is a sharp edge in the middle three-fifths of the shaft. Below it is faintly marked. The upper fifth is continued by two lines passing to the extremities of the small sigmoid notch; the posterior line is the prominent *supinator ridge*, for the supinator brevis muscle.

The *anterior surface* is concave above, and gives origin to the flexor profundus digitorum; the lower third is marked off by the oblique *pronator ridge*, directed downward and upward, limiting above the origin of the pronator quadratus. Above the middle is a medullary foramen directed upward.

The *internal surface* is smooth, and gives attachment to the flexor profundus digitorum muscle; it is subcutaneous in the lower third.

The *posterior surface* looks outward and backward; an oblique line descending from the supinator ridge to the posterior border at the junction of its upper and middle thirds marks off a triangular area for the anconeus muscle. The ridge itself gives attachment to the supinator brevis. Below this is a longitudinal ridge dividing the surface into a smooth inner portion covered by the extensor carpi ulnaris, and an outer part giving attachment from above downward to the extensor ossis metacarpi pollicis, extensor secundi internodii pollicis, or extensor longus pollicis, and extensor indicis.

The *inferior extremity* presents a rounded *head;* from its inner and back part the *styloid process* projects downward, giving attachment to the internal lateral ligament and to the triangular fibrocartilage. Posteriorly between the head and styloid process is a groove for the tendon of the extensor carpi ulnaris.

The *head* has two articular surfaces—an inferior one, upon which the triangular fibrocartilage plays, and an outer narrow convex one, for the sigmoid cavity of the radius. With the hand supine the styloid process projects at the inner and back part of the wrist; if pronated, the outer and forepart of the ulnar head is prominent between the tendons of the extensor carpi ulnaris and extensor minimi digiti.

The Radius

The radius is the outer and smaller of the two bones of the forearm. It articulates with the humerus, ulna, scaphoid, and semilunar bones, and presents for examination a shaft and two extremities.

The *superior extremity,* or *head* (eminentia capitata), is disk-shaped. On its summit is a shallow depression for the capitellum of the humerus. Its circumference is convex, broadest internally, where it rotates in the small sigmoid cavity of the ulna within the orbicular ligament. The *head* is supported by a *neck,* round and smooth, which presents behind a perpendicular ridge for part of the insertion of the supinator brevis.

The *shaft* is larger below than above, slightly curved, and convex outward and backward. Anterointernally below the neck is the *bicipital tuberosity,* rough posteriorly for the insertion of the biceps, and smooth in front for a bursa. Below this tuberosity the shaft has three surfaces and three borders.

The *anterior border* extends from the tuberosity to the base of the styloid; its upper part runs downward and outward to the middle of the bone, being called the *anterior oblique line,* and gives attachment to the supinator brevis, flexor longus pollicis, and flexor sublimis. The pronator radii teres is attached at the middle of the border, which from this point descends vertically.

The *posterior border* runs from the back of the neck to the posterior part of the base of the styloid. It is well marked only in its middle third.

The *internal* or *interosseous border* becomes prominent below, and at its lower part divides into two ridges, which include the margins of the sigmoid cavity, analogous to the division of a like border of the ulna.

The *anterior surface* is grooved longitudinally for the flexor longus pollicis muscle; at the lower end to the extent of about a quarter of the surface is an impression for the pronator quadratus. A medullary foramen is above the middle of this surface passing upward.

The *posterior surface* shows at the junction of the upper and middle thirds the *posterior oblique line*, running downward and outward to the posterior margin; below this, the entire width of the surface, is attached the extensor ossis metacarpi pollicis, and below that, by a long, narrow impression contiguous to the interosseous margin, the extensor primi internodii pollicis (extensor brevis pollicis).

The *external surface* is convex, and marked near the middle by an impression for the pronator radii teres; above this, on the area between the anterior and posterior oblique lines, is inserted the supinator brevis.

The *lower extremity* of the radius, broad and quadrilateral, presents a carpal articular surface and an ulnar articular surface. The former is divided by a line into a quadrilateral inner part for the semilunar, and a triangular outer part for the scaphoid. The articular surface for the ulna or *sigmoid cavity* is at right angles to the inferior surface, and concave from before backward. To the smooth border between these two articular surfaces is attached the base of the triangular fibrocartilage. Externally the *styloid process* projects downward. Anteriorly a transverse ridge forms the lowest limit of the pronator quadratus impression, which is continued into a vertical ridge external to that impression; between this ridge and the scaphoid facet is a triangular area for a strong band of the anterior ligament. The external and posterior aspects are marked by the following grooves from without inward; a flat groove for the extensor ossis metacarpi pollicis and extensor primi internodii or extensor brevis pollicis (next descends the styloid process); a broad groove, subdivided by a slight ridge, for the extensor carpi radialis longior and brevior; an oblique narrow groove, directed downward and outward, bounded externally by a *tubercle*, for the extensor secundi internodii pollicis (extensor longus pollicis); a broad groove for the extensor indicis, extensor communis, and extensor minimi digiti. Just above the first groove is an impression for the supinator longus.

THE BONES OF THE HAND

The skeleton of the hand consists of three segments—wrist bones, bones of the palm (metacarpal), and bones of the fingers (phalanges).

The **carpus,** or **wrist bones,** are composed of eight short bones arranged in two rows: the upper row, from the radial to the ulnar side, comprises the scaphoid, lunar (semilunar), pyramidal (cuneiform), and pisiform; in the inferior row are the trapezium, trapezoid, os magnum, and unciform.

THE ARTICULATIONS OF THE CARPAL BONES

	Superior.	External.	Inferior.	Internal.	Anterior.	Posterior.	Number.
Scaphoid	Radius	Free	Trapezium trapezoid	Os magnum semilunar	Free	Free	5
Semilunar	Radius	Scaphoid	Os magnum unciform	Cuneiform	Free	Free	5
Cuneiform	Triangular fib. cart.	Semilunar	Unciform	Free	Pisiform	Free	3
Pisiform	Free	Free	Free	Free	Free	Cuneiform	1
Trapezium	Scaphoid	Free	First metacarpal	Trapezoid second metacarpal	Free	Free	4
Trapezoid	Scaphoid	Trapezium	Second metacarpal	Os magnum	Free	Free	
Os magnum	Scaphoid semilunar	Trapezoid	Second, third, and fourth metacarpals	Unciform	Free	Free	
Unciform	Semilunar	Os magnum	Third and fourth metacarpals	Cuneiform	Free	Free	

The **metacarpus,** or **bones of the palm,** support the fingers, and consist of five long, slightly divergent bones, which *articulate* with the carpus as follows:

The *first metacarpal* articulates at its base with one bone.
The *second metacarpal* articulates at its base with four bones.
The *third metacarpal* articulates at its base with three bones.
The *fourth metacarpal* articulates at its base with four bones.
The *fifth metacarpal* articulates at its base with two bones.

It is interesting that the corresponding metatarsals articulate with exactly the same number of bones of the tarsus.

THE BONES OF THE LOWER EXTREMITY

The lower limb consists of the haunch, or hip, thigh, leg, and foot. In the haunch is the hip bone; in the thigh, the femur; in the leg, the tibia and fibula; at the knee, a large sesamoid bone, the patella; in the foot, the tarsus, metatarsus, and phalanges.

THE BONES OF THE PELVIS (PELVIC GIRDLE)

The Hip Bones (Ossa Innominata)

The *hip* or *innominate* bone (*os coxæ*), with its fellow, the sacrum, and coccyx form the pelvis. This bone is constricted in the middle and expanded above and below. In early life it is made up of three bones, the ilium, pubes, and ischium, and for the sake of description the adult bone is said to be made up of these portions.

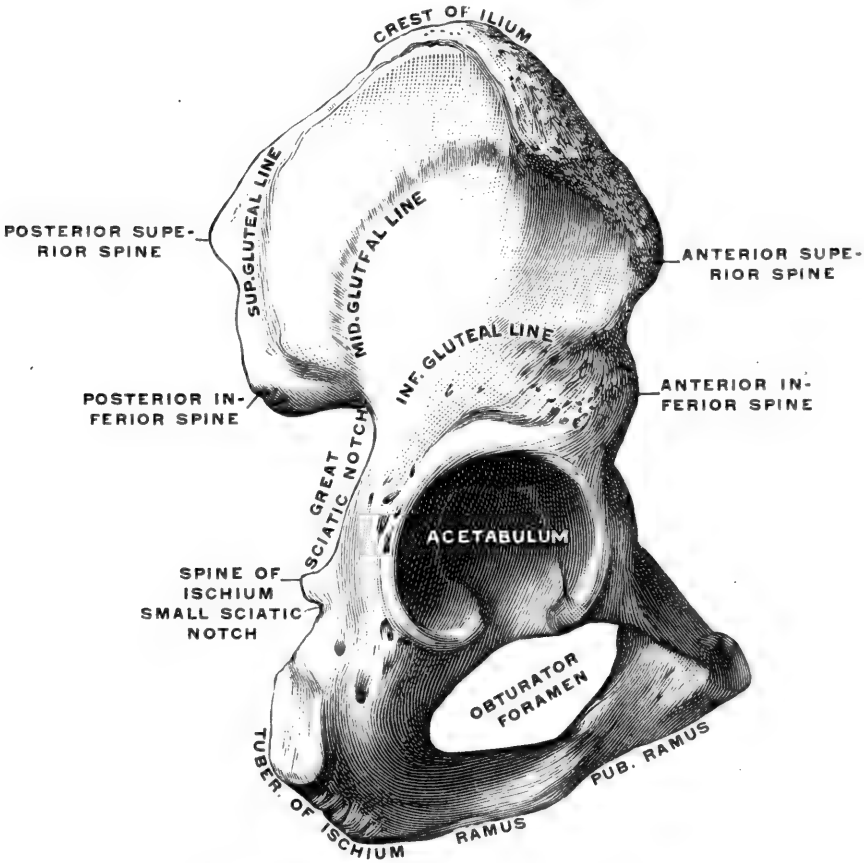
The Ilium

The *ilium* (*ilium*, flank) is the superior expanded portion, and forms less than two-fifths of the acetabulum. This portion is limited anteriorly and posteriorly by margins which diverge at right angles from each other, and superiorly by the arched *crest of the ilium.* In front the crest is concave inward, and behind it is concave outward. It is much wider near its extremities than in its middle, and there is often a marked external projection in its anterior third. On the crest are external and internal lips and a median ridge.

The anterior extremity projects as the *anterior superior spine;* below it is a concavity, the *lesser iliac notch,* and below that the *anterior inferior spine.* Behind, the projecting extremity of the crest is called the *posterior superior spine,* separated by a small notch from the *posterior inferior spine,* below which is the *great sciatic* (iliosciatic) *notch.*

To the external lip, from before backward, are attached the tensor vaginæ femoris, external abdominal oblique, latissimus dorsi, and gluteus maximus; and throughout its entire length the fascia lata. To the internal lip, from before backward, are attached the transversalis abdominalis, quadratus lum-

Fig. 19



The right hip bone, outer surface. (Testut.)

borum, and erector spinæ, and to that part of this lip corresponding to the internal iliac fossa the iliacus and iliac fascia. To the middle ridge is attached the internal abdominal oblique muscle. The anterior-superior spine has attached externally the tensor vaginæ femoris, in front the sartorius, and internally

Poupart's ligament. The straight head of the rectus femoris arises from the anterior-inferior spine of the ilium.

The *external surface,* or *dorsum ilii,* presents three curved *gluteal lines.* The posterior or *superior* one commences 2 inches in front of the posterior superior spine, and curves down and forward to the back part of the iliosciatic notch. The *middle gluteal line* begins in front about $1\frac{1}{2}$ inches behind the anterior superior spine, and arches back and down to the upper part of the notch. The *inferior gluteal line,* less strongly marked, commences just above the anterior inferior spine, and passes back to the forepart of the notch. Behind the posterior line is a semilunar surface, rough above for the gluteus maximus; the sickle-shaped space between the posterior and middle lines and iliac crest is occupied by the gluteus medius; the gluteus minimus is between the middle and inferior lines. Just above the acetabulum is an elongated mark for the reflected head of the rectus femoris.

The *internal surface* is divided into two unequal parts. The anterosuperior part is much the larger, and is called the *iliac fossa,* or venter ilii. It is concave and smooth, giving attachment to the iliacus muscle, excepting at its anteroinferior portion. It is separated from the true pelvis by the iliac portion of the iliopectineal.

To the inner side of the anterior inferior spine is a shallow groove, the *greater iliac notch,* which lodges the iliopsoas muscle as it passes under Poupart's ligament; the inner boundary of the groove is the *iliopectineal eminence,* making the junction of the pubis and ilium. The posteroinferior part is again divided, presenting from below upward (1) a smooth curved surface in the true pelvis, giving attachment in part to a portion of the obturator internus, separated from the iliac fossa by the *iliac portion* of the *iliopectineal line;* (2) the *auricular surface,* for articulation with the sacrum; (3) depressions for the posterior sacroiliac ligament; (4) a rough surface giving origin to the erector and multifidus spinæ muscles.

The Os Pubis

The *os pubis* forms the anterior wall of the pelvis, and bounds the thyroid foramen above and partly in front. It consists of a body and two rami. At the inner extremity of the body facing inward is a long oval surface marked by transverse ridges or nipple-like processes for articulation with the opposite bone; the junction is the *symphysis pubis.* The part passing down and out from the symphysis is the *descending ramus;* the upper part is the *superior* or *ascending ramus;* and the flat portion between the rami is the *body.* The pelvic surface of the body is smooth, the anterior surface rough. Anteriorly at the upper extremity of the symphysis is the *angle;* extending out from this on the superior border is the *crest,* terminating in the *spine.* The *descending ramus* is thin and flat, and joins that of the ischium at a point a little more than half-way from the body of the pelvis to the tuberosity of the ischium. The superior ramus becomes prismatic, ending externally at the acetabulum, of which it forms about one-fifth; its superior border is the *pubic portion* of the *iliopectineal line,* running from the spine of the pubis to the internal aspect of the iliopectineal eminence. The triangular surface in front of this line gives origin to the pectineus muscle; below is the *obturator crest,* extending from the pubic spine to the margin of the acetabulum. Behind the outer part of this crest on the inferior surface of the ramus is the *obturator groove,* directed from behind forward and inward.

The pubic crest gives origin to part of the conjoined tendon, the pyramidalis and rectus abdominis. To the pubic spine are inserted Poupart's ligament and the outer pillar of the external abdominal ring. From the front of the pubis, in the angle between the crest and the symphysis, arises the adductor longus muscle, and below this the adductor brevis and part of the adductor magnus. Internal to these the gracilis is attached, and external the obturator externus. Posteriorly the pubis gives attachment to the obturator internus; above this is sometimes a faint line passing from the upper margin of the obturator foramen to the lower end of the symphysis; the levator ani muscle is attached to it, and the obturator and rectovesical fasciæ.

The Ischium

The *ischium* forms the lower and back part of the hip bone, bounds the thyroid foramen below, and forms over two-fifths of the acetabulum. It presents a *body,* and below this a *tuber-*

osity continued forward into the *ramus*. The body has three surfaces, external, internal, and posterior, and three borders.

The *external surface* helps form the acetabulum; here it is smooth and concave; below this and above the tuberosity is a horizontal groove for the tendon of the obturator externus muscle.

The *internal surface* is roughly quadrilateral, slightly concave and smooth, and forms part of the wall of the true pelvis. It is limited above by the ridge marking the junction of the ischium and ilium, in front by the junction with the pubis and by the obturator foramen, and behind by the anterior margin of the great sciatic notch. Below it is continuous with the tuberosity. It gives attachment to a part of the obturator internus muscle.

The *posterior surface* is quadrilateral, getting narrow below, and continuous with the tuberosity. It is limited in front by the margin of the acetabulum, behind by the posterior margin of the bone; above it is continuous with the ilium, below with the tuber ischii. Below it presents a part of the groove for the obturator externus, and supports the pyriformis, the two gemelii, and the obturator internus.

On the posterior border, a little below its middle, is the *spine,* projecting back and in, and forming the inferior limit of the *iliosciatic notch.* Internally it gives attachment to the levator ani and coccygeus muscle, and externally to the gemellus superior. The *small sciatic notch* is between the spine and tuberosity of the ischium.

The *external border* is that part of the acetabular rim formed by the ischium. The internal border is thin, and forms the outer boundary of the obturator foramen.

The *tuberosity* presents three surfaces—external, internal, and posteroinferior.

The *external surface* is continuous above with the groove for the tendon of the obturator externus and below with the ramus. In front it is limited by the posterior margin of the obturator foramen, and externally by a prominent margin which separates it from the posteroinferior surface. Close in front of this margin a portion of the quadratus femoris is attached, while in front of it is a part of the obturator externus, and below is the adductor magnus.

The *internal surface* is smooth and slightly concave. It is limited in front by the margin of the obturator foramen; behind and below by a sharp ridge for the attachment of the falciform prolongation of the great sciatic ligament.

The *posteroinferior* surface of the *tuberosity* presents two lips and an intermediate space. The external lip gives attachment to the quadratus femoris and adductor magnus; the inner lip to the falciform portion of the great sacrosciatic ligament. The intermediate space is divided into two portions; the anterior part attaches the adductor magnus externally and the great sacrosciatic ligament internally; the posterior part has two facets, an upper and outer for the semimembranosus, a lower and inner for the biceps and semitendinosus.

The *ramus* joins the descending ramus of the pubis at the inner side of the thyroid foramen. Its outer surface is rough, and gives attachment to the obturator externus, adductor magnus, and gracilis. The crus penis and transversus peronei are attached to the inner border.

The *acetabulum,* or *cotyloid cavity,* is cup-shaped, and looks out, down, and forward. It is formed by portions of the ilium, pubis, and ischium. Scant two-fifths is ilium, a little more than two-fifths is ischium, and a little more than one-fifth pubis. It is nearly surrounded by a prominent rim which presents three depressions—a slight one anteriorly and posteriorly, and the *cotyloid notch* below. In the lateral and upper parts of the cavity is a broad horseshoe-shaped articular surface. The central part of the cup and the notch are depressed (fossa acetabuli), and contain fat and the interarticular ligament (*ligamentum teres* or *round ligament*). This non-articular surface belongs mostly to the ischium.

The *thyroid* or *obturator foramen* (foramen ovale) is internal to and below the acetabulum. It is nearly oval in the male, more triangular in the female. It is closed by fibrous membranes, except in the region of the obturator groove in its upper margin.

The Pelvis as a Whole

The *pelvis* (basin) is composed of four bones: two ossa innominata, the sacrum, and coccyx. It is divided into two parts by a plane passing through the sacral promontory, iliopectineal lines, and upper border of the symphysis. This circle is the inlet or *brim* of the *true pelvis;* the space above it really belongs to the abdomen, but is called the *false* or upper pelvis. The pelvic outlet presents three large prominences, the coccyx and the tuberosities of the ischia. Beneath the symphysis and between the puboischiatic rami is the *subpubic arch;* behind the ischial tuberosities are the sacrosciatic notches.

Position of the Pelvis.—In the erect attitude, with the heels together and toes turned out, the plane of the brim forms an angle of 60 degrees with the horizontal, that of the outlet 16 degrees. The base of the sacrum is about $3\frac{1}{2}$ inches above the upper margin of the symphysis, and the tip of the coccyx about $\frac{1}{2}$ inch above the apex of the subpubic arch. The sacrum looks down and forward, and is the inverted keystone of an arch, as its pelvic surface is broader than the dorsal; it is held in place chiefly by ligaments and by a slight bony projection into the iliac articular surface.

Differences in the Pelvis According to Sex.—In the female the bones are more slender and the muscular impressions less marked; the height is less, breadth and capacity greater; but the false pelvis is relatively narrower than in the male. The sacrum is wider and flatter, less prominent; the subpubic arch is wider, about 90 degrees (male is 75 degrees); and the space between the ischial tuberosities is greater. The thyroid foramen is broader and more triangular in the female, nearly oval in the male.

The **sacrum** and **coccyx** have been described as the false vertebræ (page 28).

THE BONE OF THE THIGH

The Femur

The *femur* (thigh bone) is the largest, longest, and strongest bone of the skeleton. In the erect position it inclines inward and slightly backward. It is divisible into a *superior extremity,* including *head, neck,* and two *trochanters; shaft;* and *inferior extremity,* expanded into *external* and *internal condyles* and *epicondyles.*

The *neck* extends upward, inward, and slightly forward, being set upon the shaft at an angle of 125 degrees. It is compressed from before backward, is broad at its base, becomes rounded at its summit, and enlarged as it joins the head. It is shorter above and in front than below and behind. Posteriorly it usually shows a shallow groove for the obturator externus tendon. Its junction with the shaft behind is marked by the posterior intertrochanteric line. The capsule of the hip-joint is attached to the neck about half an inch internal to and above this line.

The *head* is joined to the shaft by the neck. It forms more than a half-sphere, and articulates with the acetabulum. A little below and behind the centre of its surface is a depression (*fossa capitis*), the forepart of which gives attachment to the interarticular ligament (ligamentum teres) of the joint. In this hollow are one or two vascular foramina.

The *great trochanter* (to turn) is a thick process prolonged upward in a line with the external surface of the shaft to a level about $\frac{1}{2}$ or $\frac{2}{3}$ inch below the head. In front it is marked by a broad depression for the gluteus minimus. Externally an oblique line runs downward and forward, indicating the inferior border of the gluteus medius insertion. Lower down is a horizontal line continued to the *tubercle of the femur,* which is situated in front at the junction of the neck with the great trochanter; the tubercle is the meeting-place of five muscles—vastus externus, gluteus minimus, obturator internus, and two gemelli. Internally, at the base of the trochanter and rather behind the neck, is the *digital fossa,* giving attachment to the obturator externus tendon. Above and in front of this is the insertion of the obturator internus and gemelli muscles.

The upper border of the trochanter is narrow, and presents an oval mark for the pyriformis. The posterior border is prominent, and continuous with the *posterior intertrochanteric line,* limiting the neck posteriorly. Above the centre of this line is the *tubercle of the quadratus,* for attachment of the upper part of the quadratus femoris; sometimes a *linea quadrati* passes vertically down from the tubercle.

The *small trochanter* is a pyramidal eminence projecting inward and backward from the posterointernal aspect of the bone at the junction of the neck with the shaft. Its apex gives attachment to the iliopsoas tendon.

Anteriorly the neck is separated from the shaft by the *anterior intertrochanteric line,* which is the upper part of the *spiral* *line* (does not connect the trochanters); it commences at the tubercle of the femur, and runs down and in a finger's breadth in front of the small trochanter; it gives attachment to the capsular ligament, the united crureus and vastus internus muscles.

The *shaft* is arched with its convexity forward; toward the middle it is partly cylindrical, and expanded below. It presents anterior and lateral surfaces without definite lines of demarcation. All these surfaces are covered by the crureus and vasti muscles. Behind, the lateral surfaces are separated by the *linea aspera.* This is a prominent ridge extending along the middle third of the shaft, bifurcating above and below. The external lip is prolonged up to the great trochanter; its upper end is strongly marked for the gluteus maximus, constituting the *gluteal ridge.* The inner lip winds around below the small trochanter, merging into the anterior intertrochanteric line and forming the lower part of the spiral line; rising from the inner lip, a third line passes up to the small trochanter and gives attachment to the pectineus.

Inferiorly the two lips are prolonged to the condyles as the *internal* and *external supracondylar lines,* enclosing the flat *popliteal surface of the femur.* The inner line is interrupted where the femoral vessels lie against the bone, and terminates below in the *adductor tubercle.* Above the centre of the linea aspera is the medullary foramen, directed upward; a second may exist near the lower end of the bone.

To the inner lip of the linea aspera is attached the vastus internus, to the outer lip the vastus externus, and diagonally between the two the adductor magnus. Between the adductor magnus and vastus externus are the gluteus maximus and short head of the biceps; between the adductor magnus and vastus internus are the iliacus, pectineus, adductor brevis, and adductor longus. At the lower part of the popliteal space above each condyle is the origin of one head of the gastrocnemius, and externally of the plantaris.

The *inferior extremity* presents two rounded *condyles,* united in front, but separated behind by the *intercondylar notch;* the external is broader and more prominent in front, the internal longer and more prominent internally. The inner aspect of this condyle and the head of the femur face nearly the same direction.

The inferior surfaces of the two condyles are on the same level in the natural position of the femur. Opposite in front of the intercondylar notch the whole articular surface is divided by a faint transverse groove on either side into three parts—a convex surface on either condyle for the tibia and a grooved anterior surface for the patella.

The *patellar surface* is trochlear in form, marked by a vertical hollow and two lips; the external portion is wider, more prominent, and rises higher. The *tibial surfaces* are nearly parallel, but the internal one turns outward anteriorly to meet the patellar surface. The exposed lateral surface of each condyle presents a tuberosity or *epicondyle* for ligamentous attachment. The external is the smaller; above it is the impression for the outer head of the gastrocnemius; below and behind it is an oblique groove ending inferiorly in a pit from which rises the popliteus muscle; its tendon sinks fully into the groove only when the knee-joint is flexed. The inner head of the gastrocnemius rises from the upper part of the inner condyle.

The *intercondylar fossa* presents two impressions for crucial ligaments; that for the anterior ligament is on the posterior part of the inner surface of the external condyle; that for the posterior ligament is on the forepart of the external surface of the inner condyle.

The angle of the neck with the shaft is open in the fetus and child, then lessens under the weight of the body, but undergoes no change after growth is completed. The upper part of the gluteal ridge may form a *third trochanter*.

The Patella

The patella, or knee-pan, is a sesamoid bone developed in the tendon of the quadriceps extensor cruris. It is somewhat triangular, with its apex below. Its anterior surface is convex and striated, and pierced by vascular foramina. The superior border is broad and sloped from behind downward and forward, and gives attachment to the rectus and crureus portions of the quadriceps extensor.

The posterior surface of the bone presents two vertical and two transverse ridges; one vertical ridge is close to the inner margin; the other is distinct and divides the surface into two parts, the external of which is the larger and transversely concave, the inner smaller portion is convex.

The faint transverse ridges divide the articular surface into an upper two-sixths, a middle three-sixths, and a lower one-sixth. In usual extension the lower one-sixth is in contact with the femur, in mid-flexion the middle three-sixths, and in extreme flexion the upper two-sixths; also in extreme flexion the thin marginal facet is the part in contact with the inner condyle. Below the articular surface is a rough triangular area; the ligamentum patellæ springs from the apex.

Place the patella upon a plane surface, its apex away from you and its anterior surface up. It will tip to the side to which it belongs.

THE BONES OF THE LEG

The Tibia

The tibia (flute), or shin bone, is the inner and anterior of the two bones of the leg, and transmits the weight of the trunk to the foot. It articulates with the femur, fibula, and astragalus; has a shaft and two extremities.

The *superior extremity*, or head, is thick and broad transversely. It forms on each a *tuberosity*. These are continuous in front, but separated behind by a notch, the popliteal.

On the upper aspect of each tuberosity is a concave articular surface for the condyles of the femur. The *internal tuberosity* is larger than the external, and marked posteriorly and internally close below the articular surface by a horizontal groove for the semimembranosus.

The condylar surface is oval, more hollowed than the external, and longer.

The *external tuberosity* at the junction of the anterior and outer surfaces forms a prominent tubercle for the insertion of the iliotibial band; below this are often attached a few fibers of the extensor longus digitorum and of the biceps. At the posterior and under part is a flat articular surface for the fibula, looking down, out, and back. The external condylar surface is nearly circular, concave from side to side, and more or less convex from before backward; it is prolonged a little posteriorly where the popliteus glides. The periphery of each articular surface is flattened for the semilunar fibrocartilage.

Between the condylar parts is an interval which is depressed in front and behind for attachment of crucial ligaments, and elevated in the middle, forming the *spine,* the summit of which presents two compressed tubercles with an intervening hollow. The depression behind the spine is continued into the *popliteal notch,* which separates the tuberosities posteriorly. Anteriorly, at the junction of the head and shaft, is the *tubercle* or *anterior tuberosity,* the lower half of which gives attachment to the ligamentum patellæ.

The *shaft* is three-sided, diminishing in size as it descends for about two-thirds of its length, and then increasing again. It presents three borders and three surfaces.

The *anterior border* runs sinuously from the tubercle to the front of the inner malleolus; its upper two-thirds is the *crest of the tibia;* its lower third is smooth. It separates the internal and external surfaces.

The *internal border,* which is most distinct in the middle third of the bone, commences above at the back part of the inner tuberosity, ending below at the posterior border of the internal malleolus. It separates the internal and posterior surfaces.

The *external border,* or *interosseous ridge,* is thin and sharp in its middle portion. It separates the external and posterior surfaces, and gives attachment to the interosseous membrane.

The *internal surface* is convex and nearly subcutaneous. At the inner side of the tubercle are the insertions of the gracilis, semitendinosus, and double insertion of the sartorius. The *external surface* is hollowed in its upper two-thirds, where it lodges the tibialis anticus; below this the surface runs forward and is covered by the extensor tendons. The upper third of the posterior surface is crossed obliquely by the *popliteal* or *oblique line,* running down and inward; it gives origin to the soleus. Above it is a triangular area occupied by the popliteus; below it, in the middle third of the shaft, is a longitudinal ridge marking off two portions, an inner for the flexor longus digitorum, and an outer for the tibialis posticus. Below the oblique line a large medullary canal runs downward.

The *inferior extremity* is broad from side to side, and projects downward internally to form the *inner malleolus.* This malleolus is marked posteriorly by a groove for the tibialis posticus tendon, and more externally by a depression for the flexor longus pollicis. The external surface of the extremity is hollowed for the fibula, and rough for ligaments except along the lower border. Below is an articular surface, quadrilateral, concave, narrower behind than in front. It shows a slight median elevation separating two lateral depressions. Internally the cartilaginous surface is continued upon the inner malleolus.

The Fibula

The fibula (clasp), or peroneal bone, nearly equals the tibia in length; its purpose in the leg is mainly for elasticity. Its shaft is convex backward, and its lower extremity is placed a little in advance of the upper.

The *upper extremity,* or *head,* is prolonged upward at its back part into the *styloid process;* inside this is a facet looking upward, inward, and forward for articulation with the tibia; more externally is a slight excavation for the biceps; the peroneus longus is attached in front and the soleus behind. A somewhat constricted part below the head is the *neck.*

The *lower extremity,* or *external malleolus,* is pyramidal and longer than the internal malleolus; internally it shows a triangular, smooth, articular surface for the astragalus, and behind this a depression for the posterior band of the external lateral ligament.

Posteriorly is a shallow groove for the peroneus longus and brevis tendons. Externally this extremity is convex and subcutaneous.

The *shaft* presents four surfaces—anterior, posterior, internal, and external; and four borders—anteroexternal, anterointernal, posteroexternal, and posterointernal. (Gray.)

The *anteroexternal border* begins in front of the head and bifurcates below to embrace the triangular subcutaneous surface of the external malleolus; this border is between the peroneal and extensor muscles.

The *anterointernal border,* or *interosseous ridge,* is close to the preceding and parallel with it in the upper third. It terminates below at the apex of a rough surface just above the articular facet. The attached interosseous membrane separates the extensors in front from the tibialis posticus behind.

The *posteroexternal border* commences at the base of the styloid process and terminates below in the posterior border of the external malleolus. It is directed out above, then back, then slightly inward below. It separates the peronei from the flexor muscles. The *posterointernal border*, or *oblique line*, commences inside the head, and ends by joining the interosseous ridge in the lower fourth of the bone.

The *anterior surface* is very narrow above, broader and grooved below; to it are attached the extensor proprius pollicis pedis (extensor proprius hallucis), the extensor longus digitorum, and the peroneus tertius.

The *external surface* is directed outward above and backward below, and is occupied by the peroneus brevis and longus muscles.

The *internal surface* between the anterointernal and posterointernal borders is grooved for the tibialis posticus.

The *posterior surface* looks backward above and directly inward below. Its upper third attaches the soleus muscle; its lower part is rough for interosseous ligaments; to the rest of the surface is attached the flexor longus pollicis. The medullary canal opens on this surface and is directed downward.

THE BONES OF THE FOOT

The **tarsus** is composed of seven bones—the calcaneum, or os calcis, and the astragalus, the navicular, or scaphoid, three cuneiform, and cuboid,

The Os Calcis

The os calcis (heel) is the largest bone of the foot; it *articulates* with the astragalus above and cuboid in front. The bone presents six surfaces. The *posterior extremity*, or *tuberosity*, presents inferiorly two tubercles; the inner is the larger. Its posterior surface presents three districts—a smooth one above for a bursa, a ligamentous one for the tendo Achillis, and a lower convex part for the pad of the heel. The part in front of the tuberosity forms a slightly constricted *neck*.

The *internal surface* is deeply concave, and surmounted above by the *sustentaculum tali* (support of the talus, *i. e.*, ankle bone or astragalus); this projects inward on a level with the upper surface, and is grooved beneath for the flexor longus hallucis. The *superior surface* has two articular facets, separated by a groove which runs forward and outward for the interosseous ligament. The anterior facet, often subdivided into two, is on the sustentaculum, and is concave longitudinally; the other one is convex. At the forepart of the groove is a roughness for the extensor brevis digitorum. Behind the articular surfaces is a region convex from side to side and concave from before backward; above it is placed adipose tissue in front of the tendo Achillis.

The *anterior surface* is concavoconvex for articulation with the cuboid.

The *inferior surface,* in front of the tuberosity, projects in an anterior tubercle with a transverse groove in front, and gives attachment to an inferior calcaneocuboid ligament.

The *external surface* is usually flat, and presents near the centre a tubercle for the middle fasciculus of the external lateral ligament, and anteriorly often a *peroneal spine,* separating two grooves—the upper for the peroneus brevis tendon, the lower for that of the peroneus longus.

The Astragalus

The astragalus (a die), or talus, receives the weight of the body from the leg. It *articulates* with four bones—the tibia above and internally, the fibula externally, os calcis below, and scaphoid in front. Its long axis is forward and inward. The main part is the *body,* the convex anterior portion the *head,* just behind which is the *neck.*

The *superior articular surface* occupies the whole of the upper surface of the body and sends a prolongation down on either side. The trochlear part is convex from below backward, and slightly concave from side to side, wider in front than behind; its outer margin is longer than the inner, and curved, while the inner is straight. The inner lateral part is sickle-shaped for the internal malleolus; the outer lateral part is concave and triangular, and articulates with the external malleolus. *Inferiorly* there are two articular surfaces for the calcaneum; the posterior one is concave, separated by the interosseous groove from the anterior one, which is convex. The head articulates *anteriorly* with the scaphoid; at the lower and inner part, between this and the anterior articulation for the os calcis, is a facet resting upon the inferior calcaneoscaphoid ligament, the three forming one continuous surface.

The *posterior surface* is small and narrow, and marked by a groove for the flexor longus pollicis. Bounding the groove are two *tubercles*, the external more prominent and giving attachment to the posterior band of the external lateral ligament.

The Cuboid

The **cuboid** (os cuboideum) is found on the lateral aspect of the tarsus, between the os calcis and the fourth and fifth metatarsal bones, external to the scaphoid and external cuneiform bones. It is pyramidal in shape, its base directed inward and its apex outward. It presents for examination six surfaces, three **non-articular—dorsal, plantar,** and **external**; three **articular —posterior, anterior, internal.**

Articulations.—The **posterior surface** with the os calcis, the **anterior surface** (two facets) with the fourth and fifth metatarsal, the **internal surface** with the external cuneiform, (occasionally) the scaphoid.

Attachments of Muscles.—Part of the flexor brevis hallucis and a slip from the tendon of the tibialis posticus. It also receives the attachments of several ligaments.

Scaphoid or Navicular

Is situated at the inner aspect of the tarsus, between the astragalus and the three cuneiform bones. It presents for examination **anterior, posterior, dorsal, plantar, internal,** and **external surfaces.**

Articulations.—Astragalus and three cuneiform bones.

Attachment of Muscle.—Part of tibialis posticus.

The Cuneiform

The **cuneiform** bones are three in number—**internal, middle,** and **external**—found between the scaphoid behind, the first, second, and third (sometimes the fourth) metatarsal bones in front, the cuboid externally.

The **internal cuneiform** presents for examination—**internal, external, anterior, posterior, plantar,** and **dorsal surfaces.**

Articulations.—Scaphoid, middle cuneiform, first and second metatarsal bones.

Attachments of Muscles.—Tibialis anticus and posticus and peroneus longus. Also receives attachments of ligaments.

The **middle cuneiform** presents the same surfaces as the preceding bone.

Articulations.—Scaphoid, internal, and external cuneiform, and second metatarsal.

Attachment of Muscles.—A slip from the tibialis posticus.

The **external** cuneiform is situated between the scaphoid behind, the third metatarsal in front, the middle cuneiform internally, and the cuboid externally. It presents the same surfaces as the former bone.

Articulations.—Scaphoid, middle cuneiform, cuboid, and second, third, and fourth metatarsal bones.

Attachments of Muscles.—Part of tibialis posticus and flexor brevis hallucis. Also receives attachments of ligaments.

The reader is referred to the standard anatomies for a more detailed description of the tarsal bones (Author).

The Metatarsal Bones

The **metatarsal bones** are one to five in number; they articulate with the tarsal bones behind and the respective phalanges in front. They present for examination a **shaft,** a **proximal extremity,** or **base,** a **distal extremity,** or **head.**

The first is the shortest and thickest, the second is the largest, and the fifth the thinnest. Each bone has a nutrient canal on its plantar surface.

Articulations.—

First bone	(proximal	extremity)	internal cuneiform, second metatarsal (occasionally).
Second bone	"	"	internal, middle, external cuneiform. third and (occasionally) first metatarsal.
Third bone	"	"	external cuneiform, second and fourth metatarsal.
Fourth bone	"	"	external cuneiform, cuboid, third and fifth metatarsal.
Fifth bone	"	"	cuboid and fourth metatarsal.

The distal extremity of each bone articulates with the corresponding proximal extremity of the first phalanx.

Attachment of Muscles.—

First bone.	Part of tibialis anticus, peroneus longus, and first dorsal interosseous.
Second bone.	Adductor obliquus hallucis, first and second dorsal interosseous, a slip from the tibialis posticus; occasionally a slip from the peroneus longus.
Third bone.	Adductor obliquus hallucis, second and third dorsal and first plantar interossei, and a slip from the tibialis posticus.
Fourth bone.	Adductor obliquus hallucis, third and fourth dorsal and second plantar interossei, and a slip from the tibialis posticus.
Fifth bone.	Peroneus brevis, peroneus tertius, flexor brevis minimi digiti, adductor transversus hallucis, fourth dorsal and third plantar interossei.

The Phalanges of the Foot

The **phalanges** are fourteen in number for each foot, allowing three (1st, 2d, and 3d) for the second, third, fourth, and fifth toes; while the first has only two (1st and 2d).

The **first** or **proximal phalanx** is long and thin and presents a proximal extremity for articulation with the metatarsal bone; and a distal extremity for articulation with the second phalanx.

The **second phalanx** is shorter and smaller and articulates with the proximal and distal phalanges.

The **third** or **distal phalanx** is still smaller, and more flattened than the others, articulating by its proximal extremity with the second phalanx, and its expanded dorsal extremity supports the nail and the end of the toe.

Attachment of Muscles.—To first phalanges:

Great toe.	Innermost tendon of extensor brevis digitorum, abductor hallucis, adductor obliquus hallucis, flexor brevis hallucis, adductor transversus hallucis.
Second toe.	First and second dorsal interossei; first lumbrical.
Third toe.	Third dorsal and first plantar interossei; second lumbrical.
Fourth toe.	Fourth dorsal and second plantar interossei and third lumbrical.
Fifth toe.	Flexor brevis minimi digiti, abductor minimi digiti, third plantar interosseous, and fourth lumbrical.

To second phalanges:

Great toe. Extensor longus hallucis, flexor longus hallucis.
Other toes. Flexor brevis digitorum, one slip of the common tendon of the extensor longus and brevis digitorum.

To third phalanges: Two slips from the common tendon of the extensor longus and brevis digitorum, and the flexor longus digitorum.

QUESTIONS ON OSTEOLOGY

What is the anatomical position?
What is the periosteum?
Into how many and what classes are bones divided?
The skeleton is composed of what structures?

THE BONES OF THE TRUNK

How many vertebræ are there?
How many vertebræ in each region?
Describe a typical vertebra of each region.
By what characteristics may the vertebræ of the different regions be distinguished?
What are the atypical cervical vertebræ?
Of what is the atlas composed?
Why has the atlas no real spinous process?
Describe the atlas.
Describe the axis.
How many separate articular surfaces or facets has the axis?
What motion takes place between the atlas and axis?
How does the vertebra prominens differ from the type of its region?
What are the atypical thoracic vertebræ? Describe each.
What thoracic vertebræ have no articular facets on their transverse processes?
What is the sacral angle?
With what does the sacrum articulate?
What ligaments are attached to the sacrum and coccyx?
What are the surfaces of the hyoid bone?

THE BONES OF THE HEAD

Name in order the articulations of the occipital bone.
Describe the external surface of the occipital, giving muscular attachments.
What is just in front of the jugular process?
What do the anterior and posterior condylar foramina transmit?
What goes through the foramen magnum?
What lodges the occipital sinus?
Name in order the articulations of the parietal, frontal, temporal, sphenoid, malar, nasal, and lachrimal bones.
Where is the parietal foramen, and what does it transmit?
In what general direction do the grooves for the meningeal arteries run in the parietal bone?
What and where is the parietal boss?
What are the fontanelles?
Between what borders of what bones is the sagittal suture?
Describe the lambdoid and coronal sutures.
Into what portions is the frontal divided?
What do the internal angular processes articulate with?

What do the ethmoidal canals transmit?
Where is the supraorbital notch?
Into what portions is the temporal bone divided?
Describe minutely the articulations of the squamous portion, including the glenoid fossa.
Describe the zygomatic process, giving the direction of its articulation and its muscular attachment.
What is the vaginal process of the temporal, and what is attached to it?
What is the direction of the petrous portion of the temporal?
What foramina are seen entering it?
Where is the depression for the Gasserian ganglion?
What does the petrous portion articulate with?
Describe the mastoid process.
Where is and what passes through the stylomastoid foramen?
Describe the superior surface of the body of the sphenoid?
Where are the middle clinoid processes?
What passes through the optic foramen?
What is the lingula of the sphenoid?
What are the surfaces of the great wing of the sphenoid?
Give the articulation of the orbital plates of the sphenoid in order.
Name the structures passing through the sphenoidal fissure and give its relations.
Name the foramina piercing the greater wing of the sphenoid, and tell what they transmit.
Describe the roots of the lesser wing.
What does the posterior margin of the lesser wing mark?
From what part of the sphenoid do the pterygoid processes arise?
On what plate of the pterygoid process is the hamular process?
To what does the posterior margin of the inner pterygoid plate give attachment?
With what does the rostrum of the sphenoid articulate?
Describe the cribriform and perpendicular plates of the ethmoid, giving articulations.
Which turbinated bones belong to the ethmoid?
Describe the lateral masses.
Describe the malar, nasal, and lacrimal bones.
What are the surfaces of the superior maxillary bone?
Describe the surfaces of the superior maxilla.
Into which nasal fossa does the antrum of Highmore open?
Where is the apex of this antrum found?
Give the articulations of the orbital plate of the superior maxilla.
Describe the infraorbital groove.
How many teeth are there in each superior maxilla?
Describe the palate process of the superior maxilla.
Into what fossæ does the palate bone enter?
What are the processes of the palate bone?
What does the vomer separate behind?
With what does the vomer articulate?
Describe the inferior turbinated bone.
Into what portions is the inferior maxilla divided?
What are the muscular attachments of the rami?
Describe the nasal fossæ, orbital fossæ, zygomatic fossæ, spheno-maxillary fossæ, pterygoid fossæ, and temporal fossæ.

THE THORAX

How many true ribs are there?

How many false ribs are there?

In what direction do the surfaces of the ribs look in front of and behind the angle?

With how many and what structures does the head of a rib articulate?

Describe the first rib.

What structures pass between the clavicle and the first rib?

Of how many parts is the sternum composed?

What ribs articulate with each, and how?

Describe the sternum as a whole.

THE BONES OF THE UPPER EXTREMITY

Into what two portions is the clavicle divided?

Which aspect of the inner portion is concave?

Describe the sternal extremity of the clavicle.

Describe the clavicle as a whole, giving precisely the muscular attachments.

Name the angles of the scapula.

Name the margins of the scapula, and tell what is attached to each.

What is attached just above and what below the glenoid fossa?

Describe the glenoid fossa.

What are the borders of the acromion process, and with what are they continuous?

In what directions do the surfaces of the acromion process look?

Just where does the coracoid process arise?

What borders does it present, and what structures are attached to them?

What is attached to the apex of the coracoid process?

What are the surfaces of the humerus? Name and trace its borders.

What is the direction of the musculospiral groove?

What does the anatomical neck separate?

Describe the head of the humerus.

Name the muscles attached by the common extensor tendon to the external epicondyle (condyle).

Name muscles with an attachment on the internal epicondyle (condyle).

Describe the capitellum and trochlear surface.

What are the surfaces of the radius?

What surfaces has the ulna that the radius has not?

Name the borders of the radius and ulna.

Describe the extremities of the ulna and radius.

Name the muscles having attachment on the radius, stating the position and extent of each.

Into what divisions is the posterior surface of the ulna divided, and what is attached to each of these divisions?

What muscles receive partial origin from the posterior margin of the ulna?

Name the tendons which pass over the distal extremity of the radius, and point out the grooves for them.

Name the carpal bones.

Take each carpal separately and tell in order all the bones articulating with it.

Of what bones is the os innominatum made up?

Describe the crest of the ilium, giving muscular attachments.

Describe the dorsum ilii.

Describe the internal iliac surface.

What portion of the ilium forms part of the true pelvis?

What structures are attached to the antero-inferior iliac spine?

Describe the three surfaces of the body of the ischium.

What is attached to the apex of the spine of the ischium?

What are the surfaces of the tuberosity of the ischium?

How is the postero-inferior surface of the tuber ischii subdivided, and what are attached to these subdivisions?

What fraction of the acetabulum is formed by the ischium?

Into what portions is the pubis divided?

Describe the body of the pubis.

Describe the superior ramus of the pubis.

What stretches between the anterior superior iliac spine and the pubic spine?

In what direction does the head of the femur look?

Describe the neck of the femur.

Where is the digital fossa?

Describe the great trochanter, giving muscular attachments.

What is the direction of the lesser trochanter?

What is the quadrate line?

Describe precisely the linea aspera with its muscular attachments.

What are the surfaces of the femur?

Describe the lower extremity of the femur.

What is the direction of the groove for the popliteus tendon?

Describe the patella.

How may you tell to which side a fibula belongs?

What is the lowermost portion of the fibula called?

To which border of the fibula is the interosseus membrane attached?

What are the surfaces of the tibia? Give the arrangement of their muscular attachments.

Where is the popliteal notch?

Where is the spine of the tibia?

Describe the tuberosities of the tibia.

Describe the tubercle of the tibia.

Describe the distal extremity of the tibia.

What tendons groove the lower end of the tibia?

What bones form the ankle-joint?

Name the tarsal bones, and give the articulations of each.

What structures does the peroneal spine separate?

Describe the os calcis.

PART II

ARTHROLOGY, OR THE ANATOMY OF THE ARTICULATIONS

THE GENERAL STRUCTURE OF JOINTS

BONES, cartilage, ligaments, and synovial membrane enter into the formation of joints.

The articular portions of bones are enlarged to form a joint of suitable size, and so that muscles passing over the joint can act at a greater angle. The layer of bone beneath the cartilage is a compact *articular lamella.* There are three varieties of cartilage—hyaline, fibrocartilage, and yellow elastic. The hyaline and fibrocartilage are utilized in the structure of a joint.

The *ligaments* are mainly white fibrous tissue; some are yellow elastic tissue.

The *synovial membrane* is like a short wide tube covering the inner surface of the ligaments; its secretion is synovia, 95 per cent. water, 3.51 per cent. albumin and salts. There are three kinds of synovial membrane—articular, bursal, and vaginal. The former in the fetus is said to cover the articular cartilages as well as ligaments.

The *bursæ* are *mucous* as between integument and bone (subcutaneous synovial bursæ), and *synovial* between muscles or tendons and bone (subtendinous synovial bursæ).

Vaginal synovial membranes are sheaths for tendons.

THE CLASSIFICATIONS OF JOINTS

GRAY'S CLASSIFICATION OF JOINTS

Gray classifies them as *synarthrodial,* immovable; *amphiarthrodial,* mixed; and *diarthrodial,* movable.

- Synarthrodial, immovable
  - Sutura
    - vera (true)
      - dentata—*e. g.*, interparietal.
      - serrata—*e. g.*, interfrontal.
      - limbosa—*e. g.*, frontoparietal.
    - notha (false)
      - squamosa—*e. g.*, squamoparietal.
      - harmonia—*e. g.*, intermaxillary.
  - Schindylesis—*e. g.*, rostrum of sphenoid and vomer.
  - Gomphosis—*e. g.*, tooth in alveolus.
- Amphiarthrodial, mixed
  - (1) Surfaces connected by fibrocartilage, not separated by synovial membrane—*e. g.*, bodies of vertebræ.
  - (2) Surfaces covered by fibrocartilage and partially lined with synovial membrane—*e. g.*, pubic symphysis.
- Diarthrodial, movable
  - *Arthrodia,* gliding (not referable to any axis)—*e. g.*, carpal and tarsal articulations.
  - *Enarthrosis,* ball-and-socket—*e. g.*, shoulder and hip.
  - *Ginglymus,* hinge—*e. g.*, elbow, knee; no lateral motion.
  - *Trochoides,* or pivot-joint, or lateral ginglymus, a pivot within a ring—*e. g.*, altoaxoid.
  - *Condyloid,* ovoid head in elliptical cavity—*e. g.*, wrist.
  - *Reciprocal reception,* saddle-shaped—*e. g.*, carpometacarpal joint of thumb.

The **apposition of joint surfaces** is accomplished by (1) atmospheric pressure—*e. g.*, hip-joint; (2) synovial fluid; (3)

ligaments to a small extent; (4) muscles, to the greatest extent. A short muscle may act on more than one joint; the gluteus maximus extends the hip and also the knee through fascia lata which overlies the rectus femoris.

The **limitation of joint motion** is due to (1) extent of articular surfaces; (2) bony contact; (3) approximation of soft parts; (4) manner of articulation; (5) anatomical separation of joint into two, as the joints of a vertebra.

ARTICULATIONS OF THE TRUNK

THE ARTICULATIONS OF THE VERTEBRAL COLUMN

Articulations of the vertebral column comprise five sets: (1) Those between the *bodies* of the vertebræ; (2) between the *laminæ;* (3) between the *articular;* (4) the *spinous;* (5) and the *transverse* processes (the last four varieties being known as interneural).

The Ligaments of the Bodies

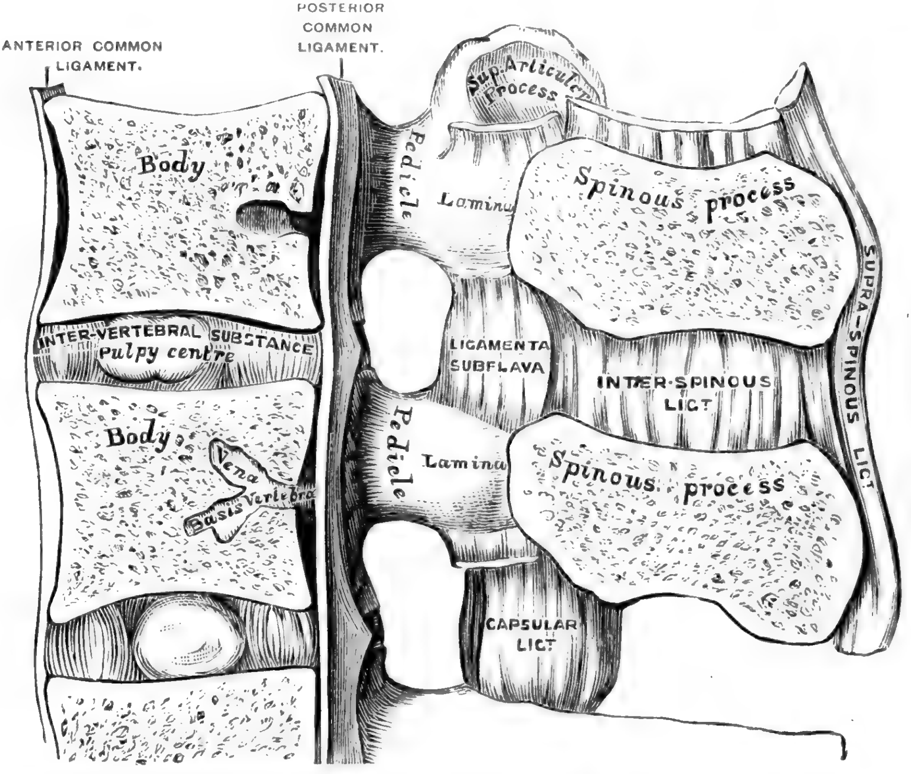
Anterior common, posterior common, and intervertebral substance.

The *anterior common ligament* extends along the front of the bodies, filling the concavities of the vertebræ from axis to sacrum; it is broader below than above, and thicker opposite the front of the body, where it is loosely connected, than opposite the intervertebral disk, where it is closely connected. It consists of several layers of fibers, the superficial set extending from a given vertebra to the fourth or fifth below it; the middle or second set extend between two or three vertebræ; and the third or deep set from one to another. The ligament splits for the passage of vessels to the vertebral body.

The *posterior common ligament* is inside the spinal canal, along the posterior surface of the bodies, and extends from the axis to the sacrum. It is broader above than below, and laterally presents a series of dentations over the intervertebral disks, and concavities over the centres of the bodies, from which it is separated by the venæ basis vertebræ. It has denser fibers than the anterior ligament, which are similarly divided into sets, and attached in a similar manner.

The *intervertebral substances* are disks of fibrocartilage placed between the bodies of the vertebræ from the axis to the sacrum. They vary in size and thickness in the different regions, being thicker behind than in front in the lumbar and cervical regions, and uniformly thick in the dorsal region. They form about

Fig. 20



Vertical section of two vertebræ and their ligaments, from the lumbar region.

one-fourth of the spinal column or one-third of the lumbar region, one-fourth of the cervical and one-fifth of the dorsal. They are connected with the anterior and posterior common ligaments, and in the dorsal region with the heads of ribs. They are composed at the circumference of laminæ $\frac{1}{100}$ to $\frac{1}{50}$ inch ($\frac{1}{4}$ to $\frac{1}{2}$ mm.) broad, of fibrous and fibroelastic tissue and fibrocartilage arranged concentrically one within the other, and surrounding in the centre a soft, pulpy mass. The laminæ are not composed of different materials, but owe their difference in appearance to the fact that they are obliquely placed, crossing each other like an X, and the light strikes them differently; some fibers run horizontally. The most external fibers resemble those of a tendon.

The central part is pulpy, soft, and yellow, containing cells in a fibrous matrix; it rises up conically when pressure is removed. The intervertebral disks are compressible, and, according to one set of measurements, a man is $\frac{1}{2}$ inch taller in the morning than at night.

The Ligaments of the Laminæ

Those connecting the laminæ are the *ligamenta subflava*, of yellow elastic tissue attached to the anterior surface of the lamina above and the posterior surface and upper margin of the lamina below. They are analogous to the intervertebral substances in front. Each ligament consists of two lateral portions, which commence on each side of the root of either articular process and pass to the convergence of the laminæ. They do not exist between the occiput and atlas, atlas and axis; they take the place of active material and help muscles pull back the flexed column.

The Ligaments of the Processes

The ligaments of the *articular processes* are *capsular*, thin, loose sacs attached to their margins and completed internally by the ligamenta subflava. They are lined by synovial membrane.

The *interspinous* ligaments are thin and membranous, interposed between the spinous processes, each extending from near the root to the summit of each spinous process. They are slightly developed in the neck, narrow in the dorsal region, and thicker in the lumbar.

The *supraspinous* ligament is a strong cord connecting the apices of the spinous processes down from the seventh cervical. Its most superficial fibers connect three or four vertebræ and its deepest neighboring vertebræ.

The **ligamentum nuchæ** continues the supraspinous ligament upward in the neck, and is attached to the external occipital protuberance. In the human subject it is only an intermuscular septum between the two trapezii. A fibrous slip is given off from its anterior surface to each cervical spinous process.

The *intertransverse* ligaments are interposed between the transverse processes. They are scattered fibers in the cervical region, rounded cords in the dorsal, and membranous in the lumbar.

The Movements of the Spinal Column

The movements of the spinal column are flexion, extension lateral movement, circumduction, and rotation—all on three axes, one transverse, one anteroposterior, and one vertical. Flexion is the freest of all movements; it compresses the disks in front and stretches the posterior common ligament and ligamenta subflava. Extension is not marked, and is limited by the anterior common ligament and spinous processes.

Flexion and **extension** are most free in the lumbar region and least in the upper dorsal; extension is greater in the neck than flexion. **Lateral movement** is most free in the cervical and lumbar regions, limited by the approximation of transverse processes. **Circumduction** is limited. **Rotation** is free in the upper dorsal and absent in the lumbar region. So the cervical region enjoys the greatest extent of each variety; the dorsal has greatest rotation, while the lumbar has none. The head and trunk may be turned through 180 degrees on either side, head and neck through 79 degrees—three-fifths of it is between atlas and axis; back and loins through 28 degrees; and in joints below this through 73 degrees.

The movements are due largely to the shape of the disks, which limit the extent of motion, but not the direction; it is proportional to their height and inversely as their area.

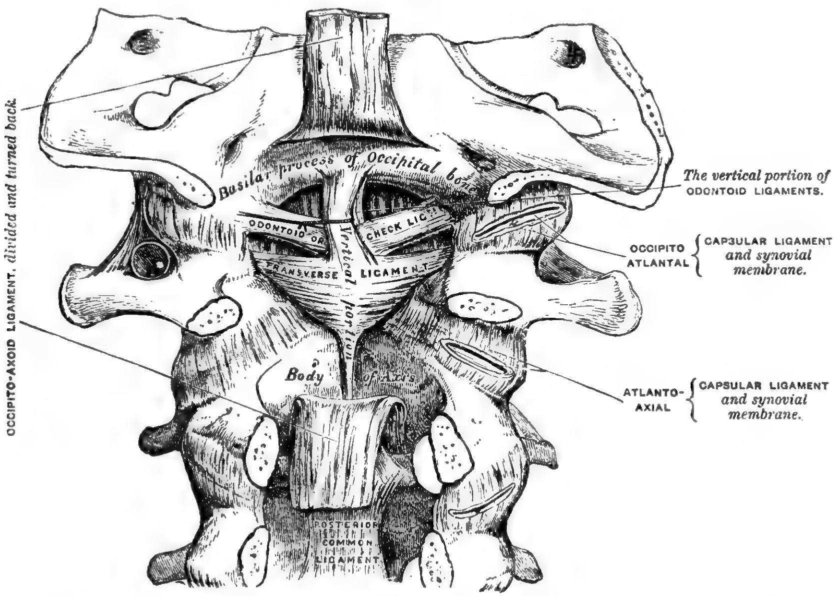
The vertebral articulations are supplied by the spinal nerves in each region; by the vertebral and ascending cervical arteries in the neck, the intercostal and lumbar below.

The Articulations of the Axis with the Atlas

The ligaments connecting the atlas and axis are two anterior atloaxoid, the posterior atloaxoid, transverse, and two capsular. The two *anterior atloaxoid* (anterior obturator) comprise a superficial rounded cord in the median line, a continuation up of the anterior common ligament to the occiput, and a deeper portion on either side from the anterior arch of the atlas to the base of the odontoid and front of the body of the axis. In front of them are the recti capitis antici majores muscles.

The *posterior atloaxoid* (posterior obturator) ligament is broad and thin, connecting the posterior arches of the two bones and supplying the place of the ligamenta subflava; it contains a little elastic tissue. Behind it are the inferior oblique muscles.

FIG. 21



Occipitoaxial and atlantoaxial ligaments. Posterior view, obtained by removing the arches of the vertebræ and the posterior part of the skull.

The *transverse* or *cruciform* ligament passes across the ring of the atlas behind the odontoid. It holds the odontoid in place, but not with such firmness as is often described; it is broad and firm in the middle, and in it is often developed a cartilaginous nodule; on each side it is attached to the lateral mass of the atlas. A small process passes up (superior crus) from its upper border to the basilar process, and another down (inferior crus) to the root of the odontoid posteriorly.

The *capsular ligaments* are thin and loose, strongest in front and externally; there is also a capsule for the anterior odontoatloid articulation. The synovial membranes are four in number—one for each capsular ligament, one for the anterior articular surface of the odontoid, and one for its posterior surface, a sort of bursa which may communicate with the occipitoatloid joints. The atloaxoid joint possesses great mobility, the greater part of the rotation of the head occurring here, and none in the occipitoatloid joints. When the bones are covered by articular cartilage, a sagittal section shows a convexity upon a convexity. With the head equipoised and eyes to the front, the muscles are at rest and ligaments tense. When the head is rotated the point of the atlas sinks down off the axis and a part projects; otherwise an already tense ligament would become more tense in rotation did not the points of attachment approach each other.

The spinal column is connected to the cranium by ligaments from the occiput to the atlas, from the occiput to the axis.

The Articulations of the Atlas with the Occipital Bone (Articuloatlantooccipitalis)

There are *anterior* occipitoatlantal and *posterior* occipitoatlantal, and two *capsular* ligaments.

The *anterior* occipitoatlantal passes from the anterior margin of the foramen magnum to the anterior arch of the atlas; behind it are the odontoid ligaments. Laterally, it is continuous with the capsular ligament. In the middle line in front it is strengthened by a strong, narrow, rounded cord, which is attached above to the basilar process of the occiput, and below to the tubercle on the anterior arch of the atlas, which is a continuation of the anterior common ligament.

The *posterior* occipitoatlantal is membranous and blended with the dura mater of the cord; it passes from the posterior margin of the foramen magnum to the posterior arch of the atlas. Laterally, it is pierced by the vertebral artery and suboccipital nerve.

The *capsular* ligaments are loose, and enclose a synovial membrane, which usually communicates with that between the posterior surface of the odontoid and transverse ligament.

This is a double condyloid joint. The movements in the joint are flexion and extension, a nodding movement through about 45 degrees; there is a slight lateral motion.

The Ligaments Connecting the Axis with the Occipital Bone

There are the *occipitoaxial* and three *odontoid.* To expose these the spinal canal must be opened. The *occipitoaxial* ligament prolongs the posterior common ligament of the spine to the front of the foramen magnum, and there blends with the dura. This is the *broad ligament* of the axis, and shows three sets of fibers; the posterior blends with the dura, the next is the continuation of the posterior common, and the most anterior or deepest set is confined to the back of the odontoid and body of the axis; this deepest layer also joins the upper part of the posterior surface of the transverse ligament, and is called the *superior appendix* of the *transverse* ligament. A bursa is often between the broad and the transverse ligament.

From either side of the apex of the odontoid process an *alar* or *check* ligament passes up and out to the inner side of the condyle of the occiput. They limit the extent of rotation. From the apex of the odontoid a middle band passes to the front of the foramen magnum.

Nerves of these joints are from the suboccipital and second cervical; *arteries* are from the vertebral.

THE ARTICULATIONS CONNECTING THE RIBS WITH THE VERTEBRÆ

There are two sets: (1) Connects heads of the ribs with the bodies—**costocentral**; (2) connects necks and tubercles with the transverse processes—**costotransverse**.

1. **Costocentral.**—*Anterior costovertebral* or *stellate capsular,* and *interarticular.* The **costocentral** consists of three bundles of fibers radiating from the head of the rib; the upper bundle passes to the vertebra above, the lower to the vertebra below, and the middle to the intervertebral substance. The first rib articulates with one vertebra, sends up a slip to the seventh

cervical, a middle one to the first dorsal, but not a lower one; there is a similar arrangement with the tenth, eleventh, and twelfth ribs. On the under edge of the stellate ligament a deep fasciculus passes from the side of the body to the under surface of the head of the rib.

The stellate ligament is continued into the cervical and lumbar regions; a slip from a next higher vertebral body and one from the adjacent intervertebral disk or body run to the root of the transverse process.

The *capsular* ligament is a loose bag, most distinct above and below, and firmly connected with the stellate ligament.

The *interarticular* ligament is a flat horizontal band of fibers passing from the intervertebral substance to the crest on the head of the rib; it divides the joint into non-communicating cavities, each lined with a separate synovial membrane. The first, eleventh, and twelfth ribs do not possess this ligament.

2. **Costotransverse.**—Articulations of necks and tubercles with the transverse processes—*superior, middle* (interosseous), and *posterior costotransverse* and *capsular* ligaments.

The *superior* ligaments are two in number: The *anterior* passes from the upper border of the neck of each rib up and out to the lower border of the transverse process and neck of the rib above. Its inner border completes an aperture between it and the articular process, corresponding to an anterior sacral foramen. Its external border is continued in a thin aponeurosis over the external intercostal muscle. The first rib does not possess this ligament. The *posterior* band is less regular, and extends from the neck of the rib up and into the transverse and lower articular process next above.

The *middle costotransverse* is very short, and connects the neck of the rib to the front of the adjacent transverse and articular process. This is lacking in the case of the eleventh and twelfth ribs.

The *posterior costotransverse* passes obliquely from the summit of the transverse process to the tubercle of the adjacent rib and is accessory to the capsule behind—wanting on the eleventh and twelfth ribs. The joint has a thin *capsular* ligament enclosing a synovial membrane.

Nerves are anterior branches of spinal nerves; *arteries,* the intercostals.

Action of these joints is elevation and depression of ribs on a transverse axis through the head of a rib and its articular process—*i. e.,* lengthwise through its neck; there are also eversion and inversion of ribs on an axis connecting their sternal and vertebral ends. No movement on a vertical axis.

THE ARTICULATIONS OF THE COSTAL CARTILAGES WITH THE STERNUM (COSTOSTERNAL)

They are *anterior chondrosternal, posterior chondrosternal, capsular,* and an *intraarticular chondrosternal.* The *anterior* one is a broad radiating band with the superior, middle, and inferior fasciculi. They intermingle with those of the opposite side and with the origin of the pectoralis major, forming a membrane over the sternum—membrana sterni. The *posterior* chondrosternal ligaments are less distinct, and are composed of radiating fibers blending with the periosteum. The *capsular* ligaments are very thin, and connected with the anterior and posterior ones. The intraarticular chondrosternal ligament is found between the second costal cartilage and the sternum, attached by one extremity to the cartilage of the second rib, and by the other to the cartilage which connects the first and second portions of the sternum. Sometimes the third rib has the same ligament situated as above, only located between the second and third pieces of the sternum. This joint has two synovial membranes.

Synovial Membranes.—The first cartilage has none, and the sixth and seventh usually have none; the third, fourth, and fifth have one; the second has two and an interarticular cartilage resembling a vertebral articulation. In old age most of these articulations disappear.

From the sixth and seventh cartilages *chondroxiphoid* (costoxiphoid) ligaments pass down and into the ensiform, strengthening the sheath of the rectus and limiting the aponeurosis of the external oblique.

THE INTERCOSTAL ARTICULATIONS (INTERCHONDRAL)

There are *external* and *internal intercostal* ligaments. The former, ligamenta intercostalia externa, lie in the nine or ten upper spaces between the anterior end of the external intercostal muscle and the sternum. The fibers are partly oblique, vertical, and transverse. The vertical and oblique fibers constitute the *ligamentum corruscans* (shining), and seem to be undeveloped bundles of the external intercostal muscle; they are strongest in the third to the seventh spaces. The transverse fibers are present in the first to the seventh spaces.

The *internal intercostal ligaments,* ligamenta intercostalia interna, are tendinous fasciculi of the triangularis sterni muscle, passing from rib to rib over one or two spaces; in the seventh and eighth spaces, sometimes sixth and ninth, they are nearly transverse.

The cartilages of the sixth, seventh, and eighth ribs, sometimes of the fifth and ninth, articulate by their lower borders with the margins of the adjoining cartilage; each articulation has a capsule and synovial membrane. All these articulations may be wanting.

In articulations of ribs with cartilages the cartilage is held in a depression in the sternal end of the rib by periosteum.

THE ARTICULATIONS OF THE STERNUM

The gladiolus is united to the manubrium by an interposed fibrocartilage, synarthrodial (Henle), or it may be diarthrodial, with a synovial membrane in 33 per cent. of cases—rarely so in childhood—and probably results from absorption. The ligaments are *anterior* and *posterior intersternal;* both consist of longitudinal fibers blending with the chondrosternal ligaments, the anterior with the pectoralis major.

The Temporomaxillary Articulation

The **ligaments** are *capsular, interarticular fibrocartilage, external lateral, internal lateral,* and *stylomandibular.*

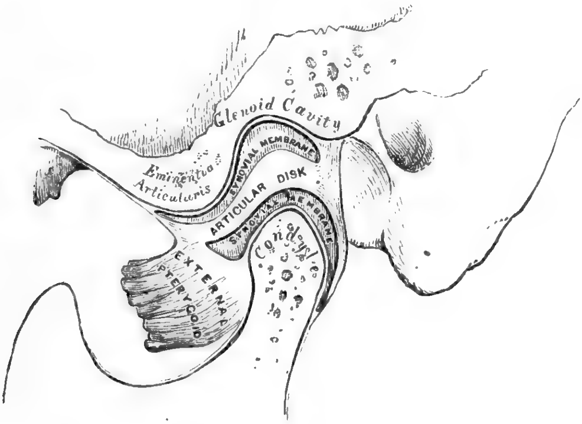
The *capsule* is very thin and loose; it passes from the edge of the glenoid fossa to the interarticular cartilage, thence to the neck of the condyle.

The **interarticular disk,** or **fibrocartilage** (articular meniscus), is placed horizontally between the jaw and temporal bone, concavoconvex above and concave below. It is connected in front with the external pterygoid muscle; it is composed of concentric fibers; its circumference is thick, and its centre may be perforated.

There are two **synovial membranes**: the upper is the larger and prolonged in front, while the lower is smaller and prolonged behind.

The *external lateral ligament* (ligamentum accessorium laterale) passes from the outer surface of the zygoma and tubercle; their lower borders down and back to the posterior surface of the neck of the lower jaw. Externally it is in relation with the temporal fascia, and internally with the joint capsule.

FIG. 22



Vertical section of the temporomandibular articulation.

The *internal lateral ligament* (ligamentum accessorium mediale) has two parts: One passes from the inner margin of the glenoid fossa to the neck of the condyle behind the insertion of the external pterygoid muscle; this is in immediate relation to the capsule, and is known as the *short internal lateral ligament*. The other passes from the spine of the sphenoid to the lingula and inner margin of the dental foramen (sphenomandibular). Between these two ligaments are the internal maxillary artery and veins, and lower down the auriculotemporal and inferior dental nerves; internal to the long band is the internal pterygoid muscle. Between the short internal lateral and the synovial membrane is a pad of soft elastic connective tissue united to the periosteum of the posterior half of the glenoid fossa; this is compressed or stretched according to the position of the condyle.

The *stylomandibular ligament* has nothing to do with this articulation; it is a band of cervical fascia connected at one end by aid of the styloglossus muscle to the styloid process, and by the other to the angle and posterior border of the lower jaw. It separates the parotid from the submaxillary gland.

Nerves of the joint are the auriculotemporal and masseteric from the inferior maxillary.

Arteries are temporal, the deep auricular, and tympanic branches of the internal maxillary.

Actions of the joint are protrusion and retraction, elevation and depression, or a rotation when one side acts. The movements in the superior and inferior compartments are of different kinds; in the upper the fibrocartilage glides forward and backward, and in the lower the condyle rotates against it on a transverse axis. Elevation and depression take place on a transverse axis through the centres of the rami—some say through the interarticular cartilages. If the depression be considerable, the condyle also has a gliding motion, carrying the cartilage with it. Rotary movement to one or other side takes place on an axis through the opposite condyle. Depression is produced by the weight of the jaw, platysma, digastric, mylohyoid, and geniohyoid muscles; elevation by the temporal, masseter, and internal pterygoid; protrusion by the external pterygoid, internal pterygoid, and superficial fibers of the masseter; retraction by the deep fibers of the masseter and posterior fibers of the temporal. It is a ginglymoarthrodial joint.

THE ARTICULATIONS OF THE VERTEBRAL COLUMN WITH THE PELVIS

The ligaments connecting the lumbar vertebra with the sacrum are the continuation of the ligaments which connect the processes of the lumbar vertebra with each other. They are the **lumbosacral** and **iliolumbar** ligaments.

The lumbosacral ligament is attached above to the transverse process of the last lumbar vertebra, in front, passing down and outward it is attached to the base of the sacrum; blending with the anterior sacroiliac and iliolumbar ligaments.

The iliolumbar ligament is attached to the tip of the transverse process of the last lumbar vertebra and passes horizontally outward to be inserted into the crest of the ilium, just in front of the sacroiliac articulation.

THE ARTICULATIONS OF THE PELVIS

The ligaments connecting the bones of the pelvis with each other are: (1) Those connecting the **sacrum** and **ilium**; (2) the **sacrum** and **ischium**; (3) the **sacrum** and **coccyx**; and (4) between the pubic bones (Gray).

1. Articulation of the Sacrum and Ilium

This is an amphiarthrodial joint, formed between the lateral surfaces of the ilium and sacrum. The anterior portion of each articular facet is covered by a thin plate of hyaline cartilage. These are in contact and partially united together by irregular patches of softer fibrocartilage, and at the upper and back portion by interosseous fibrous tissue.

The ligaments are the **anterior** and **posterior sacroiliac.**

The **anterior sacroiliac ligament** is attached to the front of the sacrum and ilium. The **posterior sacroiliac** ligament consists of an upper part (**short sacroiliac**) passing horizontally from the first and second transverse tubercles on the posterior surface of the sacrum, to the rough, uneven surface at the posterior part of the inner surface of the ilium. The lower part passes obliquely, and is attached to the third tubercle on the posterior surface of the sacrum and the posterior superior spine of the ilium; it is sometimes called the **oblique sacroiliac ligament.**

2. The Ligaments Passing between the Sacrum and Ischium

There is no joint. The **ligaments** are the **great** and **small sacrosciatic.**

The **great sacrosciatic ligament** (posterior) is triangular, and attached to the posterior inferior spine of the ilium, by its broad base, to the fourth and fifth transverse processes of the sacrum, and to the lower part of the lateral margin of that bone and the coccyx. Then passes obliquely downward, outward, and forward to the inner margin of the tuberosity of the ischium. Some of the fibers pass to the inner margin of the pubic bone (**falciform ligament**).

This ligament is united to the small sacrosciatic ligament. Its outer border forms the posterior boundary of the great sacrosciatic foramen, and below, the posterior boundary of the lesser sacrosciatic foramen. It gives attachment to some of the fibers of origin of the gluteus maximus muscle.

The **small sacrosciatic ligament** (anterior) is shorter and smaller than the great sacrosciatic ligament. It is attached by its apex to the spine of the ischium, then passes internally to be inserted by its base into the lateral margin of the sacrum and coccyx, anterior to the attachment of the great sacrosciatic ligament, with which it blends.

3. Articulation of the Sacrum and Coccyx

This is an amphiarthrodial joint, formed by the oval surface at the base of the sacrum and coccyx. The **ligaments** are the **anterior** and **posterior sacrococcygeal, lateral sacrococcygeal,** and **interarticular fibrocartilage.**

The **anterior sacrococcygeal** ligament is attached to the anterior surface of the sacrum and coccyx, blending with the periosteum. It is a continuation of the anterior common ligament.

The **posterior sacrococcygeal** ligament is divided into a **deep** and **superficial portion.** The deep is a continuation of the posterior common ligament. It arises from the lower orifice of the sacral canal, and passing downward is inserted into the posterior surface of the coccyx. It completes the lower, back part of the sacral canal. The superficial extends from the middle sacral ridge to the posterior surface of the coccyx; and encloses, partly, the sacral canal. The **lateral sacrococcygeal** ligament connects the transverse process of the coccyx to the lower lateral angle of the sacrum. The **interarticular fibro-**

cartilage is a thin articular disk, smaller than the ones between the vertebræ. It is placed between the adjoining articular facets of the sacrum and coccyx.

4. The Articulation of the Pubic Bones

It is an amphiarthrodial joint formed by the junction of the two pubic bones to form the symphysis. The **ligaments** are the **anterior, posterior, superior,** and **inferior pubic.**

Interpubic disk.—The ligaments pass from the contiguous surfaces of the bones. The **interpubic disk** consists of fibrocartilage placed between the two articulating surfaces. Each surface is covered by hyaline cartilage, attached to the bony surfaces.

ARTICULATIONS OF THE UPPER EXTREMITY

The Sternoclavicular Articulation

The **ligaments** are *capsular, anterior* and *posterior sternoclavicular, interarticular fibrocartilage; interclavicular* and *costoclavicular.*

The capsule for this joint is made up mostly of strengthening bands; it is weakest at the lower anterior angle. It completely surrounds the joint. In front a band called the *anterior sternoclavicular ligament* passes from the inner extremity of the clavicle obliquely down and into the upper part of the manubrium; the *posterior sternoclavicular ligament* passes in a similar direction, and is related behind with the sternothyroid and sternohyoid muscles.

The **interarticular cartilage** is attached above to the upper and posterior border of the inner extremity of the clavicle, and below to the junction of the first costal cartilage with the sternum, and by its circumference to the capsule; thus the cartilage of the first rib is partly within this joint. Its circumference is thicker than its centre, which may be perforated; in size and shape it varies greatly. It lessens the inequalities of the two bony surfaces, and divides the joint into two parts, each provided with a **synovial membrane.** In young bones the interclavicular notch on the sternum is covered by hyaline cartilage.

The *interclavicular ligament* is a flat band passing in a curved direction between the inner extremities of the clavicles, and is closely attached to the upper border of the sternum. Some of its fibers are connected with the periosteum of the posterior surface of the sternal end of the clavicle, and some with the back of the capsule. So if we follow the course of the connective tissue from the upper border of the clavicle, some goes to the interarticular cartilage, some to the capsule, and some forms the interclavicular ligament.

The *costoclavicular* or *rhomboid ligament* ascends obliquely from the inner part of the cartilage of the first rib back to the depression on the under surface of the sternal end of the clavicle. To its outer side is the subclavian vein. This ligament encloses the tendon of insertion of the subclavius muscle, but most of the ligament is behind the muscle, its anterior part being continued as fascia over it. Between the muscle and the posterior part of the ligament is sometimes developed the "bursa of Monro." Cruveilhier describes this ligament and bursa as the *costoclavicular articulation.*

Nerves, second and third cervical by descendens noni. **Arteries,** neighboring muscular branches. **Motion** is not a gliding, but axial on the fibrocartilage. Elevation and depression of the shoulder produce movement here on a transverse axis through the costoclavicular ligament; movement of shoulder forward and backward, on a vertical axis through the same point. It is an arthrodial joint.

THE ACROMIOCLAVICULAR ARTICULATION

The acromioclavicular is an arthrodial joint formed by the outer extremity of the clavicle and the inner margin of the acromial process of the scapula.

Ligaments are *capsular* (superior and inferior acromioclavicular), *interarticular fibrocartilage; coracoclavicular,* consisting of the *trapezoid* and *conoid* ligaments.

There is a weak **capsule** to this joint, really a fibrous covering of the synovial membrane; it is strongest above, being strengthened above and below by bands designated by some as the *superior* and *inferior acromioclavicular ligaments.* The **interarticular cartilage** is usually present in some form, either hanging from the edge of the clavicle in the upper part of the joint or covering the whole articular surface of the acromion, or in 3 out of 400 cases wholly dividing the joint into two cavities.

The *coracoclavicular ligaments* connect the clavicle more firmly with the scapula; there are three. The *posterior coracoclavicular* comprises the *trapezoid* and *conoid.* The trapezoid is external, and attached below to the upper surface of the coracoid, and above to the oblique line passing forward and outward on the under surface of the clavicle. Its outer border is free, and its internal border unites with the conoid, forming an angle projecting backward. This checks forward movement of the clavicle.

The *conoid* is posterior and internal, and attached by its apex to the base of the coracoid, and by an expanded base to the conoid tubercle and a line internal to it on the under surface of the clavicle. This checks backward movement of the clavicle. Between these two ligaments a bursa may be developed, and between them is also the extremity of the subclavius muscle.

The **synovial membrane** is usually single, or double when the interarticular cartilage is complete.

Nerves, suprascapular and circumflex. **Arteries,** suprascapular and acromial thoracic. **Movements** of joint, gliding and rotation.

THE PROPER LIGAMENTS OF THE SCAPULA

They pass between portions of the scapula, the coracoid and acromial processes, but are not parts of a joint.

The ligaments are coracoacromial, superior, and inferior transverse.

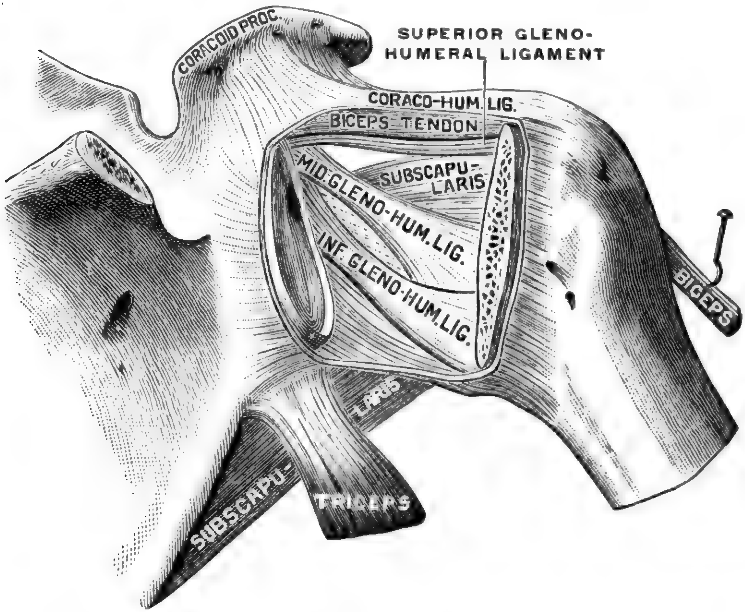
The coracoacromial is attached by its apex to the summit of the acromion, and by the base to the whole length of the outer border of the coracoid process of the scapula. The superior transverse ligament is attached to the base of the coracoid process and the inner margin of the suprascapular notch. The inferior transverse (spinoglenoid) is attached to the outer border of the spine and the margin of the glenoid cavity. It is not always present.

The Shoulder-joint

The **ligaments** are *capsular, glenoid, coracohumeral, transverse humeral.*

This is a ball-and-socket joint, peculiar (1) in the large size of the head of the humerus and shallowness of the glenoid cavity; (2) looseness of the capsule; (3) intimate relation of the muscles with the capsule; (4) relation of the biceps tendon to the joint. The glenoid articular cartilage is thinnest at its centre—$\frac{2}{25}$ inch (2 mm.).

Fig. 23



Shoulder-joint, rear view. The hind part of the capsular ligament and most of the head of the humerus have been removed. (Testut.)

The **capsule** encircles the articulation, attached above to the margin of the glenoid cavity, beyond the glenoid ligament, and below to the anatomical neck of the humerus. It allows the bones to be separated more than an inch; it is strengthened by tendons of muscles which may be reckoned as ligaments, viz., above by the supraspinatus and tendon of biceps, externally by the infraspinatus and teres minor, below by the long head of the triceps, and internally by the subscapularis. There is a weak place in the capsule uncovered by muscle between the edges of the teres major and subscapularis; vessels and nerves enter here.

The superficial fibers of the capsule are longitudinal, and deeper ones are circular, forming a truncated cone, with its narrow end toward the scapula. Below are folds in the capsule which become straight in raising the arm.

The *glenoid ligament* is a fibrocartilaginous rim attached to the margin of the glenoid fossa to form a deeper cavity; it is triangular on section, and $\frac{3}{25}$ inch (3 mm.) broad at its base. It is partly formed by the biceps tendon above as it bifurcates at its attachment, and by the triceps below, the fibers being arranged in concentric rings. Its intrinsic fibers are fused with the capsule.

The **synovial membrane** lines the capsule and covers the outer side of the glenoid ligament, and is continued a short distance over the cartilage on the head of the humerus. The long tendon of the biceps passing through the capsule is enclosed in a tubular sheath of synovial membrane, and so does not really enter the synovial cavity. A rounded protrusion of the synovial membrane, *bursa intertubercularis,* clothes the upper part of the bicipital groove as far as the insertion of the pectoralis major and latissimus dorsi. From within the tube of synovial membrane there passes to the tendon of the biceps a *retinaculum* of longitudinal bundles of connective tissue.

The joint cavity communicates with a large bursal sac beneath the subscapularis tendon, and occasionally with that under the tendon of the infraspinatus muscle.

The deltoid muscle is separated from the capsule by a large bursa which does not communicate with the joint.

Among the **strengthening bands** of the capsule is the *coraco-humeral ligament,* rising from the outer border of the coracoid, spreading out upon the upper and posterior wall of the capsule, and inserted into the great tuberosity of the humerus.

The *ligamentum coracoglenoidale* is a part of the coraco-humeral, rising with it and passing backward and outward at right angles on the surface of the capsule to the upper margin of the glenoid cavity.

The *transverse humeral ligament* is a part of the capsule between the tuberosities.

When the joint is viewed from the inside, there are three supplementary bands seen on the anterior part of the capsule. The highest is the *glenoideohumeral* or *Flood's ligament,* which passes from the upper part of the anterior margin of the glenoid cavity to the upper end of the bicipital groove. The middle band is the *internal glenoideobrachiale* of Schlemm. It is a thin fold arising from the same point as the preceding ligament. It descends obliquely outward to be lost on the capsule beneath the subscapular tendon, passing to the small tuberosity (Quain). The lowest band is the *ligamentum glenoideobrachiale inferior,* or broad ligament of *Schlemm,* which rises from the middle of the anterior margin of the glenoid cavity and passes down and out parallel to the internal ligament of Schlemm to the under portion of the neck of the humerus.

The head of the humerus is held in place by the subscapularis, supraspinatus, infraspinatus, deltoid, biceps, and triceps muscles, and also by atmospheric pressure.

The **nerves** supplying the joint are circumflex and suprascapular.

The **arteries** are anterior and posterior circumflex and suprascapular.

The **movements** of the joint are in every direction.

Flexion is possible to 45 degrees without involving other joints, produced by the pectoralis major, anterior fibers of the deltoid, coracobrachialis, and by the biceps if the elbow is fixed. This occurs on a transverse axis through the great tuberosity and glenoid cavity. Flexion is limited by tension of the posterior part of the capsule and by the small tuberosity abutting against the coracoid; the movement is continued by rotation of the scapula.

Extension through 15 degrees is produced by the latissimus dorsi, teres major, posterior fibers of the deltoid, and the triceps if the elbow is fixed. Extension is hindered by superior muscles and approximation of the great tuberosity and acromion.

Abduction through 90 degrees is performed by the deltoid, aided by the supraspinatus, on an anteroposterior axis through the anatomical neck of the humerus; further motion calls into play accessory joints, viz., the upper portion of the trapezius elevates the peak of the shoulder, and the lower fibers of the serratus magnus pull the inferior angle of the scapula forward, rotating that bone, which raises its external angle. Two other joints share the motion—the acromioclavicular until its yielding is stopped by the coracoclavicular ligaments, next the sternoclavicular joint until its motion is checked by the costoclavicular ligament. So three chief muscles are concerned in raising the hand above the head, and two joints besides the shoulder-joint. Freest motion is up and forward. The angle between the scapula and clavicle changes to secure adaptation of the former to the chest wall.

Adduction is accomplished by the subscapularis, pectoralis major, latissimus dorsi, and teres major. Total rotation is through 90 degrees, limited by capsule and muscles; it is freest externally and backward; *rotation in* is produced by the subscapularis, latissimus dorsi, and teres major; *rotation out* by the infraspinatus, supraspinatus, and teres minor. *Circumduction* is a combination of all the angular movements in succession.

The Elbow-joint

The elbow is a **hinge-joint** formed by the trochlea of the humerus resting in the greater sigmoid cavity of the ulna; while the capitellum or radial facet of the humerus articulates with the lesser sigmoid cavity of the ulna.

The **ligaments** are *capsular,* with thickened bands and the *orbicular ligament;* the **thickened bands** are known as *anterior* and *posterior, internal lateral* and *external lateral.*

The **capsule** includes the coronoid and part of the olecranon fossæ, a part of the internal epicondyle, but not the external, the tips of the coronoid and olecranon processes. The *anterior* thickened portion of the capsule passes from the point of the inner epicondyle and from the front of the humerus above the coronoid fossa to the anterior margins of the coronoid process, and externally into the orbicular ligament. Superficially is an oblique band passing down and out from the internal epicondyle to the orbicular ligament. The fibers under these are vertical, the *anterior ligament of Barkow,* and the deepest are transverse. The *posterior* part of the capsule passes from the lower end of the humerus, leaving the upper part of the olecranon fossa exposed to the posterior and external margins of the olecranon process, a little behind the articular surface. The lowest fibers are transverse, bridging over part of the olecranon fossa; the upper fibers are vertical, thickest in the median line, and pass through a fatty pad in the upper part of the fossa. These vertical fibers are *Barkow's posterior straight cubital* ligament; on either side of it the capsule is as thin as a bursa.

The *internal lateral ligament* is fan-shaped, rises from the lower and back part of the root of the inner epicondyle, and consists of three portions: (1) A posterior *humeroolecranon* part, helping form the groove for the ulnar nerve; (2) an anterior *humerocoronoid* part; and (3) an *olecranocoronoid* portion, deepening the sigmoid cavity.

The *external lateral ligament* is not so distinct as the internal; it is attached above to a depression below the external epicondyle, and below to the orbicular ligament and to the upper part of the interosseous border of the ulna (not into the radius, or its rotation would be impaired). It gives some strengthening bands to the anterior ligament, forming a cruciform arrangement. The supinator brevis arises from this ligament in part. The brachialis anticus muscle inserts a band into the anterior ligament, the triceps a band into the posterior. The anconeus arises partly from the capsule between the external condyle and external border of the olecranon.

The *orbicular ligament* is described under the superior radioulnar articulation.

The **synovial membrane** is extensive, lines the capsule and orbicular ligament, and enters into the articulation between all three bones.

There are inequalities between the sigmoid fossa and trochlea which are filled in with synovial membrane or fatty pads; there is another pad in the small sigmoid cavity. The capsule is reinforced by intracapsular and extracapsular pads, both in the coronoid and olecranon fossæ. This allows free gliding of muscles. The triceps pulls up the wrinkled capsule in extension, the brachialis anticus in flexion.

The **muscles in relation to the joint** are, in front, the brachialis anticus; behind, the triceps and anconeus; externally, the supinator brevis and supinatoextensor group; internally, the pronatoflexor group.

The **bursæ related to the joint** are: (1) Superficial olecranon bursa between the tendon of the triceps and the skin; (2) deep olecranon, between the tendon of the triceps and the bone; (3) at the inner margin of the brachialis anticus; (4) bicipital bursa, between the tendon of the biceps and the bone; (5) epicondylar bursæ, subcutaneous; (6) sometimes a *retro-epitrochlear* behind the inner epicondyle, related to the ulnar nerve.

Nerves are from the ulnar, median, musculospiral, internal cutaneous, and nerve of Cruveilhier (from the branch of the musculocutaneous to the biceps).

Arteries are derived from an anastomosis between the inferior and superior profunda, anastomotica magna, anterior and posterior ulnar recurrent, interosseous recurrent, and radial recurrent.

Action.—The humeroulnar joint possesses flexion and extension, no lateral movement or rotation.

Flexion of 150 degrees is possible, produced by the supinator longus, biceps, brachialis anticus, and muscles from the inner condyle; it is checked by contact of soft parts, posterior part of the capsule, and posterior part of the internal and external lateral ligaments, not by bone.

Extension (after flexion) goes through 150 degrees by the triceps, anconeus, extensors of the wrist, and common extensors of the fingers; it is checked by the anterior part of the capsule and anterior parts of the external and internal lateral ligaments, not by bone.

Supination (rotation *out*) and *pronation* (rotation *in*) occur through 90 degrees in the radioulnar and radiohumeral joints on an axis through the head and neck of the radius and styloid process of the ulna. Supination is performed by the biceps strongly, by the supinator longus and brevis and extensors of the thumb; pronation by the pronator radii teres and pronator quadratus; in this last motion there is a "winding up" of the biceps and supinator brevis. These rotary movements are *checked* by the oblique ligament, orbicular, and capsular, by the interosseous membrane, by the inferior articulation, and by muscles. If sliding of the soft parts on the ulna is hindered, pronation and supination are largely checked.

THE RADIOULNAR ARTICULATION

It is divided into **superior, middle,** and **inferior radioulnar articulations.**

The Superior Articulation

This is a trochoid or pivot joint, formed by the inner side of the head of the radius rotating within the lesser sigmoid cavity of the ulna.

The **orbicular ligament** surrounds the head of the radius; it forms about $\frac{4}{5}$ of an osseofibrous ring and is attached to the lesser sigmoid cavity of the ulna.

The synovial membrane lines the smooth, inner surface, and is continuous with that which lines the elbow-joint.

The Middle Radioulnar Articulation

The **oblique ligament** (chorda transversalis) is a flatly rounded cord running from the tubercle of the ulna on the coronoid process down and out to a point on the radius a little below the bicipital tuberosity. Its fibers have an opposite direction to those of the interosseous ligament. The oblique may be wanting, or may exist as a tendinous slip to the flexor longus pollicis; it may be double, the upper band passing from the small sigmoid notch and orbicular ligament to a point above the bicipital tuberosity.

The **interosseous ligament** (**membrane**) connects the interosseous ridges of the radius and ulna. The fibers pass down and into the ulna in such a direction that if the hand press against resistance the radius would drag the ulna after it. The ligament is divisible here and there into several layers, some fibers coming from the anterior surface of the radius. It is deficient above, commencing on the radius at the insertion of the oblique ligament, leaving a space between the two for the posterior interosseous vessels. Just above its lower end is an oblique opening between two layers of the ligament for the passage of the anterior interosseous vessels. The lower edge is almost vertical, the fibers ending higher on the ulna than on the radius and running in a direction opposite to the fibers above; this lowest split between the ligament and ulna is filled with fat and covered by the pronator quadratus muscle. Some fibers go to the posterior annular ligament.

The Inferior Radioulnar Articulation

This is a **lateral ginglymus** joint between the head of the ulna and sigmoid cavity of the radius.

The **ligaments** are the *anterior* and *posterior radioulnar* and *triangular fibrocartilage* The anterior and posterior ligaments are narrow bands passing transversely over the joint, as indicated by their names.

The **triangular ligament** is placed beneath the ulna, attached by its apex to the base of the styloid process; its under surface articulates with the cuneiform.

The **synovial membrane** is very extensive, the *membrana sacciformis*.

Actions are supination and pronation.

THE ARTICULATIONS OF THE WRIST AND CARPUS

The Radiocarpal or Wrist-joint

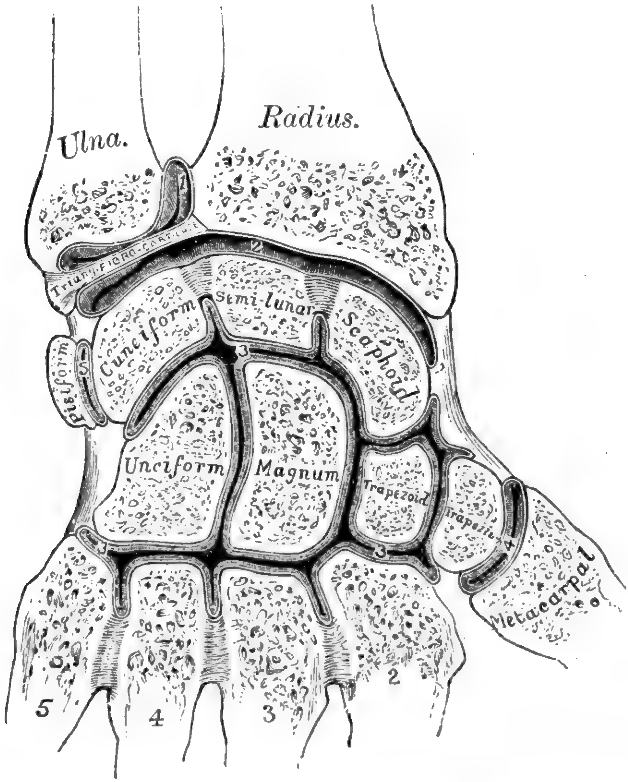
This is a **condyloid** articulation between the radius and triangular cartilage above, the scaphoid, semilunar, and cuneiform below.

The **ligaments** are *external* and *internal lateral, anterior* and *posterior*. The first two are rounded cords passing respectively from the styloid process of the radius and ulna to the end carpal bones of the first row. The *anterior ligament* is a broad membranous band connecting the anterior surfaces of the bones forming the articulation. The *posterior* ligament is less strong than the anterior, and passes from the radius to the dorsum of the first three carpals.

Nerves are from the ulnar and posterior interosseous.

Actions are flexion, extension, abduction, adduction, and circumduction.

FIG. 24



Vertical section through the articulations at the wrist, showing the five synovial membranes.

The Ligaments of the Carpus

They are in three sets: (1) **articulations of the first row** have *two dorsal, two palmar,* and *two interosseous* ligaments; (2) **articulations of the second row** have *three dorsal, three palmar,* and *three interosseous* ligaments; (3) **articulations of the two rows** with each other have *anterior, posterior, external lateral,* and *internal lateral* ligaments.

The Carpometacarpal Ligaments

The first metacarpal bone and the trapezium have a capsule and separate synovial membranes. The joints between the carpus and four inner metacarpals have *dorsal, plantar,* and *interosseous* ligaments.

The **synovial membranes** of all the joints in the carpus and wrist proper are *five* in number (Fig. 24).

The Remaining Ligaments of the Metacarpus and Phalanges

Of the metacarpals with each other, there are the *dorsal, palmar,* and *interosseous* ligaments; their digital extremities are connected by a narrow band, the *transverse* ligament, presenting four grooves for tendons.

The metacarpophalangeal articulations have *anterior* and *two lateral* ligaments. The interphalangeal articulations also have *anterior* and *two lateral ligaments.*

Actions are flexion, extension, and very limited abduction, adduction and circumduction.

ARTICULATIONS OF THE LOWER EXTREMITY

The Hip-joint

It is an **enarthrodial** or **ball-and-socket joint.** The articular surface of the head of the femur is more than a hemisphere; any section of the bony acetabulum through its centre is less than 180 degrees.

The **ligaments** are *cotyloid, transverse, teres, capsular; accessory* are *orbicular zone, iliofemoral, iliotrochanteric, pubofemoral, ischiofemoral,* and *ischiocapsular.*

The *cotyloid* consists of connective tissue arranged circularly; it is strengthened and fastened to the edge of the acetabulum by short fibers rising at different points and interlacing at acute angles. It is prismoid on section, and embraces the head of the femur so tightly that air does not enter the joint. Both its sides are covered with synovial membrane. Inferiorly the cotyloid becomes flat and bridges over the acetabular notch at the *transverse ligament;* it turns one surface upward and one down; one edge looks within and limits a split through which, enveloped in fat, bloodvessels enter the socket; the other edges pass uninterruptedly into the cotyloid ligament.

The *articular cartilage of the acetabulum* is 2 mm. thick, a little thinner toward the centre; that on the head of the femur is thickest at the centre, $\frac{1}{5}$ inch (4 mm.). The fossa acetabuli contains a fat pad.

FIG. 25

Hip-joint, showing inverted Y-ligament. (Bigelow.)

The *ligamentum teres* is misnamed, being neither ligamentous nor round; it is somewhat triangular. It is planted by its apex into the fossa on the posterior inferior quadrant of the head of the femur, and rises from the notch and fossa acetabuli. Unoccupied space around it is filled with synovia. A cross-section of it discloses an outer firm and an inner loose part;

it is made up of transverse fibers limited by the transverse ligament and longitudinal fibers, which arise from the acetabular fossa, and some pass in from the capsule under the transverse ligament. Its function may be (1) to check movement; (2) a remnant from lower animals; (3) to carry synovia and vessels (this is most probable). The motion it checks is a most unnatural one, viz., is tense, with thigh flexed, adducted, and rotated in. Sometimes it is a mere synovial fold, and sometimes is wanting.

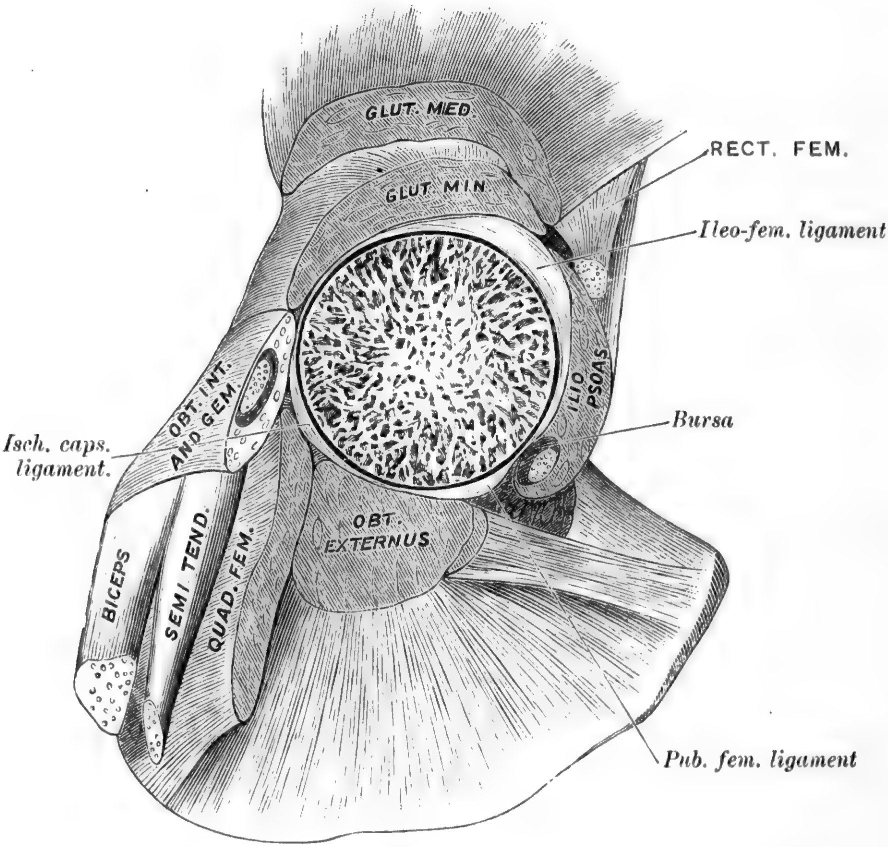
The **capsule** springs from the outer surface of the base of the cotyloid ligament, from the edge of the acetabulum and margin of the transverse ligament; below it is attached to the anterior intertrochanteric line and to the back of the neck of the femur in a line parallel to the posterior intertrochanteric and about $\frac{1}{2}$ inch above it. The digital fossa is outside the capsule; it is impossible to have a true extracapsular fracture of the neck of the femur. At the attachment to bone the innermost layer of the capsule is reflected in smooth or longitudinal folds (retinacula) up the neck to the articular cartilage of the head, with which it fuses. This layer of the capsule lined with epithelium is a thin but firm membrane, seen by the microscope to be formed of parallel, transverse, or circular bands; outside this are connective-tissue layers separating it from the accessory bands.

The **accessory ligaments** are either circular or longitudinal. The circular bands form the *zona orbicularis,* which is most distinct on the under wall of the capsule, because less covered here by the longitudinal bands. It occupies the middle third of the capsule, and continues upon the upper and lower thirds as transverse or scattering bands of connective tissue.

The accessory longitudinal bands spring from each of the three bones forming the acetabulum, and are only lacking in that part of the capsule which rises from the transverse ligament. They go between the circular fibers, over them, or end in them.

The *iliofemoral ligament* extends obliquely across the front of the capsule, attached above to the lower part of the anterior inferior spine, and from a point behind this, just above the acetabulum, and below to the whole length of the anterior intertrochanteric line. It is covered by a fine layer of circular fibers, and pierced by some fibers of origin of the outer head of the rectus femoris. At its insertion it is divided into two bands—one to the lower part of the line and base of the small trochanter, and one to the upper part. Sometimes it does not divide, forming then a triangular band. It is called the *inverted Y-ligament* of Bigelow and ligament of Bertin. It is of great importance in maintaining the erect position of the body, and requires 250 to 750 pounds for its rupture.

FIG. 26



Relation of the muscles to the hip-joint. (Henle.)

The *iliotrochanteric* ligament rises from beneath the anterior inferior spine, and may be considered as the upper arm of the Y-ligament or as fibers parallel to it, and inserted into the anterior part of the base of the great trochanter.

The *pubofemoral* ligament may be described in three parts at its origin: The first is a continuation of the fascia over the pectineus muscle, and goes from the iliopectineal eminence down between the iliopsoas and pectineus muscles to the lowest part of the capsule; a second fasciculus (pubofemoral of Barkow) comes beneath the pectineus from the whole length of the obturator crest, and joins the first set outside that muscle; a third set comes from the upper ramus of the pubis and upper obturator spine and joins the others; it gives origin to some fibers of the obturator externus.

The *ischiocapsular* ligament rises from the lower part of the edge of the acetabulum and neighboring portion of the ischium, and ends in the lower and outer portion of the orbicular zone.

The *ischiofemoral* ligament (Macalister) rises from the upper part of the ischial tuberosity, passes over the groove between this tuberosity and the acetabulum, and is attached to the back of the neck at a point midway between the two trochanters. It is often fused with the capsule.

Synovial processes occupy the joint outside the fatty pad of the fossa acetabuli and in the region of the neck of the femur; broad flaps hang from the capsular covering of the neck, or thin tufts give a velvety appearance to the inner surface of the capsule.

The iliopsoas bursa opens into the joint anteriorly, and is analogous to the subscapular bursa of the shoulder; it may act as an accessory pouch for synovial supply as needed. Where the capsule is thin, muscles strengthen it; in front is the iliopsoas; above, the rectus and gluteus minimus; internally, the obturator externus and pectineus; behind, the pyriformis, two obturators, two gemelli, and quadratus femoris.

Nerves are from the sacral plexus, great sciatic, nerve to quadratus femoris muscle, obturator, accessory obturator, and anterior crural.

The **arteries** are from the obturator, sciatic, gluteal, internal and external circumflex.

Movements are in every possible direction. Flexion and extension pass through 139 degrees on the dead subject, about 86 degrees on the living; abduction or adduction through 90 degrees, and rotation through 51 degrees. *Flexion is checked* by soft parts and by hamstring muscles (with knee extended), by posterior part of the capsule and the ischiocapsular ligament; *extension is checked* by the anterior part of the capsule and the iliofemoral ligament; *rotation out,* by the upper arm of the iliofemoral; *rotation in,* by the ischiocapsular and ischiofemoral ligaments; *abduction,* by the pubofemoral ligament and the lower and inner parts of the capsule and impact of the head of the femur; *adduction,* by the upper arm of the Y-ligament, by the iliotrochanteric ligament, and by soft parts.

Iliofemoral ligament checks extension and tendency to tip backward, rotation out, and adduction. *Pubofemoral* checks abduction. *Ischiofemoral* checks rotation in, extraordinary flexion.

The Knee-joint

This is a **double condylar joint,** really consisting of three articulations, one between each condyle and the tibia, one between the patella and femur which is partly arthrodial. The ligamentum mucosum indicates the original separation of the synovial sac into two.

The bones are covered by hyaline cartilage to the average depth of $\frac{1}{4}$ inch (4 mm.). On the anterior part of the condylar surface is a transverse groove caused by indentation of the fibrocartilages; the part above this groove articulates with the patella.

The **ligaments** are: **Capsular, anterior** or **ligamentum patellæ, posterior, internal lateral, two short external lateral, anterior** or **external crucial, posterior** or **internal crucial, two semilunar fibrocartilages, transverse,** and **coronary.**

The **capsular ligament** consists of thin but strong fibrous membrane, which is strengthened by heavy bands, inseparately connected with it. In front it blends with and forms part of the lateral patellar ligaments and fills in the space between the anterior and lateral ligaments, blending with them. Above it is deficient. Behind it the fibers are mostly vertical, and are attached above to the condyles and intercondyloid notch of the femur; below they are attached to the posterior part of the head of the tibia, uniting with the origins of the gastrocnemius, plantaris, and popliteus muscles. It is connected to the posterior ligament.

The **anterior** or **ligamentum patellæ** is the central portion of the common tendon of the extensor muscles of the thigh. It is a strong, ligamentous band, about three inches long, attached above to the apex and the rough posterior surface of the patella; below, to the lower part of the tubercle of the tibia. The lateral portions of the extensor tendon blends with the fascia later to form the **lateral patellar ligaments.** The posterior surface is separated above from the synovial membrane by a fold of fat; below, a synovial bursa separates it from the tibia.

The **posterior ligament** is a broad, flat band attached above to the upper margin of the intercondyloid notch of the femur; below, to the posterior margin of the head of the tibia. Passing superficially, from the back part of the inner tuberosity of the tibia, obliquely upward and outward to the posterior part of the outer condyle of the femur, is the strong fasciculus derived from the tendon of the semimembranosis. This is called the **posterior ligament of Winslow.** It blends with the posterior and internal lateral ligaments.

The **internal lateral ligament** is a broad, flat, membranous band, attached above to the internal tuberosity of the femur; below, to the inner tuberosity and surface of the tibia to the extent of about two inches. It is crossed at its lower part by the tendons, from before backward, of the sartorius, gracilis, and semimembranosus muscles. The **external lateral ligaments** are divided into **long** and **short** external lateral ligaments. The **long external lateral** arises from the external tuberosity of the femur and passes to the head of the fibula. Its outer surface is in relation with the tendon of the biceps femoris muscle, which it splits.

The **short external lateral** is attached above to the back part of the external tuberosity of the femur, and behind and running parallel with the long external lateral ligament is inserted into the styloid process of the fibula. The popliteus muscle and the inferior external articular vessels and nerves pass beneath both the long and short ligaments.

The **crucial ligaments** are two interosseous ligaments found within the intercondyloid portion of the joint—the **anterior** or **external** and **posterior** or **internal arcuate ligaments.**

The **anterior** or **external** is attached to the depression in front of the spine of the tibia and the external semilunar cartilage, and passes obliquely upward, backward, and outward to be inserted into the inner and back part of the intercondyle of the femur.

The **posterior** or **internal** is attached to the depression behind the spine of the tibia, to the popliteal notch, and to the external semilunar cartilage; passing upward, forward, and inward it is inserted into the outer and forepart of the internal condyle of the femur. It is in relation with the anterior ligament in front; the capsule, behind. These two ligaments cross each other to resemble the letter X.

The **semilunar fibrocartilages** are two in number—**internal** and **external.** They are lamellæ which serve to deepen the articular surfaces of the head of the tibia for the condyles of the femur. They rest on the head of the tibia; their upper concave surfaces are in relation with the condyles, except at the inner third, where they blend with the crucial ligaments; their outer surfaces are convex, and attached to the inner surface of the capsular ligament.

The **internal** semilunar fibrocartilage is nearly a semicircle, is broader behind than in front; its anterior, thin extremity is attached to the depression on the anterior margin of the tibia, in front of the anterior crucial ligaments; its posterior extremity is attached to the depression behind the spine of the tibia and the posterior crucial ligament. The **external** semilunar fibrocartilage forms nearly an entire circle. The anterior extremity is attached in front of the spine of the tibia and behind and external to the anterior crucial ligament, with which it blends; the posterior extremity is attached behind the spine of the tibia, anterior to the posterior extremity of the internal cartilage. This cartilage gives off a strong fasciculus, the **ligament of Wrisberg,** which passes upward and outward to the inner condyle of the femur.

The **transverse ligament** passes between the anterior margins of the internal and external cartilages; sometimes it is absent.

The **coronary ligaments** connect the cartilages with the margins of the head of the tibia. They are essentially portions of the capsular ligament.

The Bursæ related to the Joints are arranged as follows:

I. Anterior Bursæ

Prepatellar	Pretibial
1. Subcutaneous.	1. One in front of the tubercle of the tibia.
2. Subfascial.	2. One between the ligamentum patellæ and the tubercle of the tibia.
3. Subaponeurotic.	3. Subpatellar.

II. Subcrural Bursæ

III. Lateral Bursæ

Externally	Internally
1. Beneath the outer head of the gastrocnemius.	1. Beneath the inner head of the gastrocnemius.
2. Beneath the tendon of the popliteus.	2. Beneath the semimembranosus.
3. Between the tendon of the popliteus and the external lateral ligament.	3. Between the semimembranosus and semitendinosus.
4. Bicipital, between the biceps, fibula, and external lateral ligament.	

The **nerves** are from the obturator, anterior crural, by branches to the vastus externus, internus, and crureus, external and internal popliteal, three branches from each, and sometimes the great sciatic.

The **arteries** are: The anastomotica magna of the femoral, five articular of the popliteal, anterior tibial recurrent, posterior tibial recurrent, and a descending branch from the external circumflex.

Movements to be considered are those between each condyle and tibia, between the femur and patella. It is a hinge, and owes its special motions to peculiarity of ligaments rather than to conformation of bone, as in the case of the elbow. *Flexion* and *extension* have a maximum of 140 degrees; flexion is arrested mostly by the anterior crucial ligament; the anterior fibers of the posterior ligament are also stretched. At the beginning of flexion both crucial ligaments become relaxed; both are stretched in extension, especially the posterior short fibers of the posterior crucial. In extension the lateral ligaments are tense, and do not allow any motion but flexion. Flexion and extension do not occur in a purely hinge-like manner; the same part of one articular surface is not always applied to the same part of another; the axis of motion is not a fixed one. The motion of the femur on the tibia is likened to that of a carriage wheel on the ground; it advances or recedes while it rotates.

The semilunar cartilages are loosely attached, and move forward in extension and backward in flexion of the joint like movable wedges; as the condyles roll and present different curvatures, each cartilage contracts or expands to fit the surface above. The actual contact of the femur with the tibia is hardly more than linear.

In extension the anterior capsular wall is raised by the subcrural muscle; in flexion the posterior wall has two muscles to prevent its bulging into the joint. The semimembranosus acts through its oblique ligament when the flexors from the thigh and pelvis are in operation; the popliteus, through the arcuate ligament when the plantaris and those attached to the os calcis act.

As flexion increases, rotation is possible, and increases to a total of 39 degrees, due to a relaxation of the lateral and crucial ligaments. *Rotation out* (supination) is most extensive, as the external lateral ligaments are more loose than the internal; this occurs on an axis through the inner condyle and inner tuberosity of the tibia. This motion is checked by the internal lateral ligament and the winding of the posterior crucial around the spine of the tibia. *Rotation in* (pronation) on an axis through the outer condyle and outer tuberosity of the tibia is never more than 5 to 10 degrees; this motion is checked by the anterior crucial ligament and by the twisting of these crucial ligaments around each other.

At the close of full extension there is a *movement of adaptation,* or gliding back of the inner condyle upon the tibia; this axis is through the external condyle. At the beginning of flexion a reverse motion takes place.

The *movements of the patella* are partly gliding and partly those of coaptation. In extension only the lower sixth of the patellar articular surface is in contact with the femur; in semiflexion, the middle three-sixths; in full flexion, the upper two-sixths, as the ligamentum patellæ pulls it down in front of the joint.

The Synovial Membrane.—It encloses the articular cavity of the knee-joint. It is the largest and most extensive synovial membrane in the body, consisting of a cul-de-sac beneath the quadriceps extensor tendon, which communicates by a small orifice with a synovial bursa between the patella and femur (bursa subpatellaris). It extends beneath the vastus internus and externus muscles, and is separated from the anterior ligament by the capsule and adipose tissue (**infrapatellar pad**). In this region it gives off a triangular prolongation containing a few ligamentous fibers, the **ligamentum mucosum,** which extends from below the patella to the intercondyloid notch; the latter gives off two thin folds, **ligamentum alaria,** which extend laterally between the femur and patella. The membrane covers the internal surfaces of the ligaments, surrounds the crucial ligaments and cartilages. The portion between the quadriceps extensor muscle and the femur is supported during the movements of the knee by the subcrureus muscle, which is inserted into the upper part of the capsular ligament. It forms a cul-de-sac between the groove on the back of the external semilunar cartilage and the popliteus muscle.

THE LIGAMENTS BETWEEN THE BONES OF THE LEG

The Upper Tibiofibular Articulation

The **capsule** rises from the tibia about $\frac{1}{5}$ inch (5 mm.) above the articular surface, elsewhere from its edge; it passes to the contiguous margins of the fibular surface, and generally encloses a little space at the lower part of the joint, covered only by periosteum, where the tibia and fibula rest upon each other.

Accessory bands are *anterior* and *posterior ligaments* (ligamenta capituli fibulæ anteria et posteria). The former consists of one or more bands from the front of the head of the fibula to the front of the outer tuberosity of the tibia; some fibers of the peroneus longus and extensor longus digitorum arise from it. The posterior ligament connects the bones in a similar manner, and is covered by one head of the soleus. This joint cavity may communicate with the knee-joint. Fat fills the space between the capsule and interosseous membrane.

The joint surfaces **move** in a transverse and sagittal direction, more in the former; the purpose of the movement is to allow a gliding at the lower ends of the bones. This is an arthrodial joint.

The Interosseous Membrane

Between the bones is the *interosseous ligament* or *membrane,* its fibers passing down and out to the fibula; it separates the flexor from the extensor muscles. Above is an opening for the anterior tibial vessels, and below another for the anterior peroneal. Close to the upper tibiofibular joint is a band of fibers analogous to the oblique ligament of the forearm, running in a direction opposite to that of the fibers of the rest of the membrane. If the forearm be pronated and compared with the leg, the two interosseous ligaments run in parallel directions.

The Inferior Tibiofibular Joint

The *inferior tibiofibular joint* presents *interosseous, anterior, posterior,* and *transverse* **ligaments.** The *interosseous* is continuous with the interosseous membrane above. The *anterior* and *posterior* ligaments connect corresponding surfaces of the two bones. The *transverse* is under the posterior ligament, projects below and connects the margins of the bones, and forms part of the articulating surface for the astragalus. This is an arthrodial joint.

The Ankle-joint

The tibiotarsal articulation is a ginglymus, or hinge joint, formed by the lower extremity of the tibia and its malleolus and the external malleolus of the fibula, the former articulating with the upper convex surface and internal articular facet of the astragalus; the latter, with the external articular facet of the astragalus.

The **ligaments** are *anterior tibiotarasl, posterior tibiotarsal, internal lateral,* and *external lateral.*

The *anterior* is broad and thin, and connects the tibia and astragalus. The *posterior* consists mostly of transverse fibers between the tibia and astragalus.

The *internal lateral,* or *deltoid,* has a superficial and a deep layer; the former rises from the apex, anterior and posterior borders of the internal malleolus, and passes forward to the scaphoid and inferior calcaneoscaphoid ligament, downward to the posterior edge of the sustentaculum tali, and backward to the astragalus, all to different bones; the deep layer is strong and thick, and passes from the apex of the malleolus directly to the inner surface of the astragalus.

The *external lateral ligament* has three fasciculi—one from the anterior part of the external malleolus to the astragalus, a middle one from the apex of the malleolus to the os calcis, and a posterior one from the back of the malleolus to the astragalus.

THE ARTICULATIONS OF THE TARSUS

The **calcaneoastragaloid** articulation is an arthrodial joint, formed by the astragalus and os calcis connected by a capsule which is thickened at certain points, forming five ligaments—**internal** and **external calcaneoastragaloid, anterior** and **posterior calcaneoastragaloid,** and **interosseous.**

The **articulation of the os calcis with the cuboid** is an arthrodial joint, the two surfaces being connected by four ligaments—**superior** or **dorsal calcaneocuboid, internal calcaneocuboid, two plantar,** divided into **long and short calcaneocuboid.**

The **superior** connects the upper surfaces of the two bones.

The **internal** is somewhat interosseous, blending with the **superior calcaneoscaphoid** ligament.

The **long plantar** or **calcaneocuboid** is the longest of all the ligaments of the tarsus; it is attached to the under surface of the os calcis, from near the tuberosities, as far as the anterior tubercle; its fibers passing forward to be attached to the ridge on the under surface of the cuboid bone, some of the more superficial fibers passing to the second, third, and fourth metatarsal bones.

This ligament passes over the groove on the under surface of the cuboid bone, converting it into a canal for the tendon of the peroneus longus.

The **short plantar** or **calcaneocuboid** extends from the anterior tubercle of the os calcis to the cuboid bone behind its peroneal groove.

The Articulation of the Os Calcis and Scaphoid.—These bones do not, as a rule, articulate; the ligaments are **superior** or **external calcaneoscaphoid, inferior** or **internal calcaneoscaphoid.** The superior ligament blends with the internal calcaneocuboid ligament to form the **ligamentum bifurcatum.**

The **articulation of the astragalus with the scaphoid** is an arthrodial joint; the only ligament is the **superior astragalo-scaphoid.**

The following tarsal articulations are connected by **dorsal, plantar,** and **interosseous** ligaments—the scaphoid with the three cuneiform bones; the scaphoid with the cuboid; the cuneiform bones with each other; the external cuneiform with the cuboid.

Synovial Membranes.—The **calcaneoastragaloid articulation** has two—one for the posterior calcaneoastragaloid articulation, another for the anterior calcaneoastragaloid articulation; the latter synovial membrane is continued forward between the contiguous surfaces of the astragalus and scaphoid bones. The **calcaneocuboid ligaments** are lined with a distinct membrane. The **astragalus** and **scaphoid bones** are lined by a membrane continued forward from the calcaneoastragaloid articulation. The following tarsal joints and their ligaments are lined with a membrane which is part of the great tarsal synovial membrane—the scaphoid with the cuneiform bones; the scaphoid with the cuboid; the cuneiform bones with each other; the external cuneiform bone with the cuboid.

The Remaining Ligaments of the Foot

The tarsometatarsal joints have *dorsal, plantar,* and *interosseous* ligaments; the latter are three in number.

The intermetatarsal articulations have *dorsal, plantar,* and *interosseous* ligaments; the digital extremities are united by a *transverse metatarsal* ligament which connects the great toe to the others.

Metatarsophalangeal and interphalangeal articulations have each *plantar* and *two lateral ligaments.*

QUESTIONS ON ARTHROLOGY

THE ARTICULATIONS OF THE TRUNK AND HEAD

What are the ligaments of the vertebræ?
Name and describe the special ligaments of the rotation vertebræ.
Name and describe the ligaments binding the ribs to the vertebræ.
Describe the temporomaxillary articulation.

THE ARTICULATIONS OF THE UPPER EXTREMITY

How many synovial sacs are there in the sternoclavicular and sternoacromial joints?
What are the ligaments of the shoulder-joint?
Is the shoulder-capsule taut or lax?
What are the strengthening bands of the shoulder-capsule?
Is the long tendon of the biceps within the shoulder synovial cavity?
What bursæ communicate with the shoulder-joint's synovial cavity?
Name the tendons in relation to the shoulder-joint, stating the relation of each.
To what is the external lateral ligament of the elbow attached below?
To what part of the olecranon process is the outer portion of the posterior ligament of the elbow attached?
What are the ligaments of the wrist?

THE ARTICULATIONS OF THE LOWER EXTREMITY

What are the ligaments of the hip-joint?
Where is the capsule of the hip-joint attached to the femur?
Describe fully Bigelow's inverted Y-ligament.
Give the relations of tendons and muscles to the hip-joint.
Mention what limits the various motions at the hip-joint.
To what degree is extension possible at the hip?
What are the internal ligaments of the knee-joint? What the external?
Describe the posterior oblique fasciculus, the crucial ligaments, the semilunar cartilages, and the ligamentum mucosum
What relation does the popliteus tendon bear to the external lateral lateral ligaments?
What are the fasciculi of the external lateral ligament of the ankle?
Describe the deltoid ligament.

PART III

MYOLOGY, OR THE ANATOMY OF THE MUSCULAR SYSTEM

THE MUSCLES IN GENERAL

Myology is the branch of anatomy which treats of the muscles. Muscles are divided into **voluntary striated,** under the control of the will; **involuntary non-striated,** not under the control of the will. Between these two groups we have the cardiac muscle, which is an **involuntary striated** muscle.

In the description of a muscle is included the **origin,** meaning its more fixed point or central attachment; and the **insertion,** the movable point to which the force of the muscle is exerted.

THE FASCIÆ IN GENERAL

These fibrous structures are arranged in two layers, superficial and deep, each with its subdivisions.

The *superficial fascia* is subcutaneous all over the body; its web contains subcutaneous fat, the *panniculus adiposus,* and often superficial muscles, the *panniculus carnosus.* There is no fat in this layer in the eyelids, penis, and scrotum. Beneath the fatty layer is usually another, devoid of fat, for the support of vessels and nerves.

The *deep fasciæ* or *aponeuroses* are made of strong fibrous tissue covering the body more or less, forming *aponeuroses of investment* or *of insertion* for muscles. Near some joints it is strengthened by transverse bands, forming *retinacula* or *annular ligaments* to hold tendons close to bones.

Tendons are pearl-colored, fibrous cords, differing in length and thickness; they are round or flat, of considerable strength, and devoid of elasticity. Their structure consists of fibrils of white fibrous tissue which run in an undulating parallel course. Very few arteries or veins are found in the tendons.

THE MUSCLES AND FASCIÆ OF THE NECK

The **neck muscles** are mostly vertical, a superficial or anterior group, somewhat resembling the recti abdominis; a deep or posterior group corresponding to the intercostals and serratus anticus.

I. THE ANTERIOR NECK MUSCLES

Long Muscles.—1. *Platysma myoides* (M. subcutaneus colli) is a pale thin muscular sheet over the front and side of the neck and lower part of the face. **Origin,** the skin and subcutaneous tissue over the deltoid, pectoral, and trapezius muscles in a line from the anterior end of the second rib to the acromion; fibers pass up and in over the clavicle, and are **inserted** into the lower jaw; the two muscles meet at the hyoid, and the right overlaps the left one; the posterior fibers blend with the depressor anguli and orbicularis muscles and fasciæ. The muscle does not rise from bone; but is inserted into bone, muscle, and fascia.

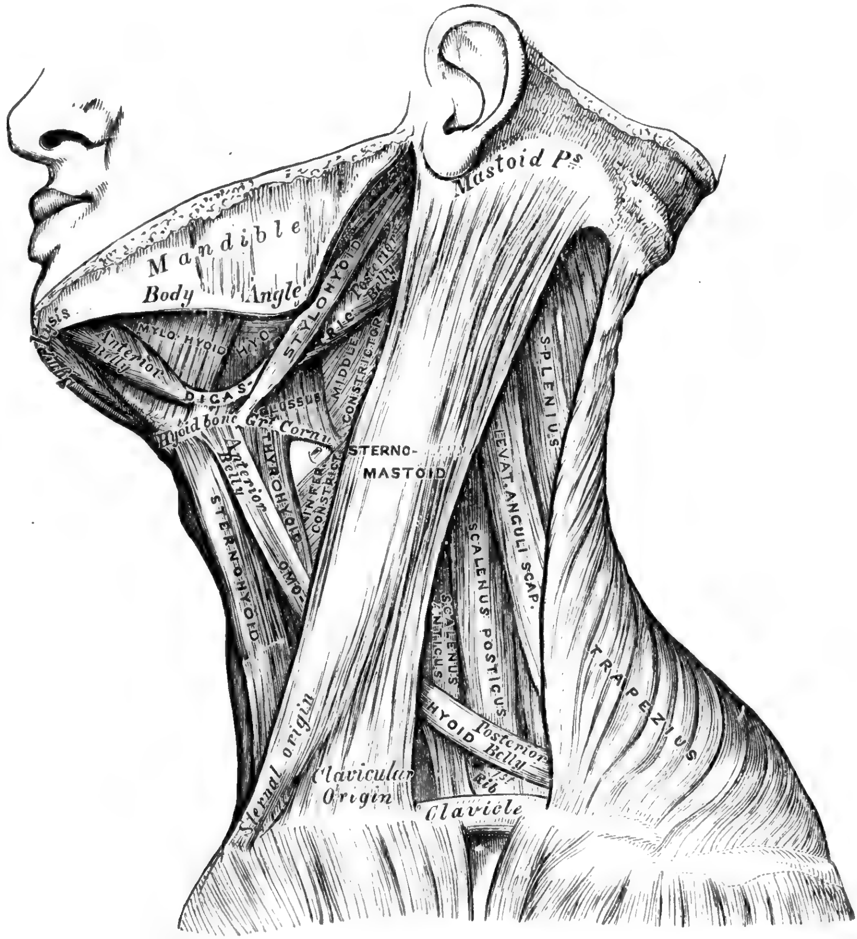
Nerves.—Inframaxillary branch of the facial, but as this unites with the superficial cervical nerve, it may get some spinal innervation.

Action.—Draws angle of the mouth down and out; may depress the lower jaw; being curved, it tends to redress itself, carries skin of the neck forward, and is said to be useful in singing by removing pressure from the great vessels; used in swallowing and expressing sudden terror; some authorities say propels saliva from the parotid.

The Deep Cervical Fascia (Anteriorly)

This passes from the trapezius muscle beneath the platysma over the posterior triangle of the neck, invests the sternomastoid, and passes over the anterior triangle to the median line. It is attached below to the clavicle, and perforated by the external jugular vein; attached above to the lower jaw, and becomes the *parotid fascia* and *stylomandibular ligament.* In front it is attached to the hyoid bone, and splits below the thyroid gland; the anterior layer goes to the anterior surface

FIG. 27



Muscles of the neck and boundaries of the triangles.

of the sternum, and the posterior, covering the sternohyoid and thyroid muscles, is attached to the interclavicular ligament; between these two layers is the *suprasternal space,* extending a short distance on either side behind the sternomastoid as the *supraclavicular recess.* Prolonged from the deeper layer, a fascia invests the posterior belly of the omohyoid and holds it down to the first rib, there connected with the costocoracoid membrane. A process (pretracheal portion) also passes behind the depressors of the hyoid, invests the thyroid body, passes to the trachea, forms the carotid sheath, and extends to the pericardium. Deepest of all is the *prevertebral fascia.* Inside the pharyngeal muscles is the *pharyngeal aponeurosis,* outside them their proper fascial layer (buccopharyngeal), connected to the prevertebral fascia by areolar tissue, forming the *retro-pharyngeal space.* A prolongation of the prevertebral fascia forms the *axillary sheath.*

2. *M. Sternocleidomastoideus* (its full name should mention its insertion into the occipital bone).—**Origin,** *sternal head,* thick and round, from anterior surface of the manubrium; *clavicular,* from the inner third of the upper surface of the clavicle. The two portions meet, pass up and back, and **insert into** the anterior border and outer surface of the mastoid and outer half or more of the superior curved line of the occiput, to meet the trapezius. Spinal accessory nerve pierces the under surface of the external portion.

Nerves.—Both by the spinal accessory, offsets of which are joined by the second cervical.

Actions.—The two sternomastoids draw the head and neck forward toward the sternum; one, acting slightly, flexes the head (extends, Henle) and flexes laterally and rotates, so that the face looks up and toward the opposite side. Fixed above, the muscles elevate the thorax in forced inspiration.

3. *Digastric muscle* (M. biventer mandibulæ) has two bellies united by a rounded tendon; the posterior belly **rises** from the digastric fossa on the mastoid portion of the temporal bone, passes down, in, and forward toward the hyoid bone. The anterior belly is **attached** close to the symphysis of the lower jaw, on its inner surface close to the inferior margin, and directed down, back, and slightly outward; the intervening tendon is attached to the body and great cornu of the hyoid by an aponeurosis and by the stylohyoid muscle, which is pierced by the digastric tendon. The anterior bellies of the two muscles are connected by a dense aponeurosis.

Nerves.—Anterior belly by the mylohyoid branch of the inferior dental from the third division of the fifth nerve; posterior belly by the facial.

Actions.—Either an elevator of the hyoid or depressor of the lower jaw, according to which is fixed; its insertion is not close enough to the hyoid to allow independent action of either belly.

The Hyoid Bone Muscles

1. BETWEEN THE BASE OF THE SKULL AND THE HYOID.—*M. Stylohyoideus.*—**Origin,** by narrow tendon from the back of the styloid process near its root; **insertion,** usually divided for transmission of the digastric tendon, and the two portions pass ununited to the hyoid at the junction of the great cornu and body; almost always a slip ends in the digastric tendon.

May be wanting, may be double; inserted into the digastric tendon; fibers continued to the omohyoid, thyrohyoid, or mylohyoid muscles. *M. stylohyoideus alter* (stylochondrohyoideus or stylohyoideus profundus), from styloid process to the small cornu, accompanying or replacing the stylohyoid ligament.

II. BETWEEN THE THORAX AND THE HYOID.—**First Layer.**—1. *M. Sternohyoideus.* — **Origin,** posterior surface of manubrium sterni and sternoclavicular joint, or from joint and clavicle, from clavicle only, sometimes from the first costal cartilage; **insertion,** inner half of the lower border of the hyoid body. Its inner border approaches its fellow; are far apart below.

2. *M. omohyoideus,* ribbon-shaped, has two bellies and an intermediate tendon. **Origin,** upper border of the scapula near the notch or from the transverse ligament; passes forward under the trapezius across the scaleni, beneath the sternomastoid, then vertically **to** the lower border of the hyoid, partly beneath and partly in front of the sternohyoid insertion. Its tendon beneath the sternomastoid at the level of the cricoid cartilage is enclosed in the deep cervical fascia, which is prolonged down to the sternum and first costal cartilage, while the fascia investing its posterior belly descends to the clavicle.

Second Layer.—1. *M. sternothyroideus* lies behind the sternohyoid, and **rises** from the posterior surface of the manubrium internal to the sternohyoid, variably from the first and second costal cartilages, diverges from its fellow; **inserted** into the oblique line of the thyroid cartilage, covering some fibers of the inferior constrictor.

III. Muscles between the Lower Jaw and the Hyoid Bone.—**First Layer.**—*M. Mylohyoideus.*—**Origin,** from the mylohyoid ridge of the lower jaw, extending from the last molar tooth nearly to the symphysis; fibers **pass** inward, back, and downward, the larger number into the median raphe between the two muscles which extends from near the symphysis to the hyoid, hinder ones to the body of the hyoid, on the lower part of the anterior surface; the posterior border is free; the two muscles form the "diaphragm of the mouth."

Second Layer.—*M. geniohyoideus* has a narrow **origin** from the inferior mental spine; fibers pass straight back to the anterior surface of the body of the hyoid, and frequently send a small slip to the small cornu over the hyoglossus or another to the great cornu. It may be blended with its fellow or doubled.

Nerves.—Stylohyoid by facial, mylohyoid by mylohyoid branch of the inferior dental of the third division of the fifth; all the others of this group attached to the hyoid bone apparently by the hypoglossal, but really by the first, second, and third cervical nerves *via* the communicans or ansa and descendens hypoglossi.

Actions.—*Sternohyoid* and *omohyoid* depress the hyoid bone; the *sternothyroid* depresses that cartilage, may make the vocal cords tense, but with the thyrohyoid depresses the hyoid bone; the latter also draws up the larynx; may relax the vocal cords, and produces descent of the epiglottis. These muscles restore the larynx and hyoid after the act of swallowing, and depress them in utterance of low tones. The infrahyoid muscles may act in forced inspiration.

The *mylohyoid* and *geniohyoid* elevate the hyoid and draw it forward, or depress the lower jaw, depending upon which is fixed; the former raises the floor of the mouth and forces food back. The *stylohyoid* acts only on the hyoid bone; aided by the middle constrictor, it draws it up and back.

The Muscles of the Tongue

M. geniohyoglossus, fan-shaped, is placed vertically in contact with its fellow. **Origin,** superior mental tubercle; its lower fibers **pass to** the superior surface of the body of the hyoid and side of the pharynx, the superior to the tip of the tongue, and the intermediate to the whole length of the tongue, some decussating across the median line.

M. hyoglossus is flat and quadrate. **Origin,** whole length of the great cornu and lateral part of the anterior surface of the hyoid body; **insertion,** posterior half of the tongue, where fibers spread forward and inward over the dorsum, joining the styloglossus. The fibers from the hyoid body may be called the *basioglossus,* those from the great cornu the *kerato-glossus.*

The *chondroglossus* is often described as a part of the above, but is separated from it by the pharyngeal fibers of the genio-hyoglossus. **Origin,** inner side of the base of the small cornu and from part of the superior surface of the hyoid body; its fibers **end on** the dorsum of the tongue near the middle line.

M. Styloglossus.—**Origin,** front of the styloid process near the apex, and largely from the stylomaxillary ligament; **insertion,** side and under part of the tongue as far as the tip, decussating and blending with the hyoglossus and palatoglossus.

The *lingualis* is the intrinsic tongue muscle, presenting inferior, superior, transverse, and vertical fibers, with a median fibrous septum.

Nerves.—Motor supply by the hypoglossal.

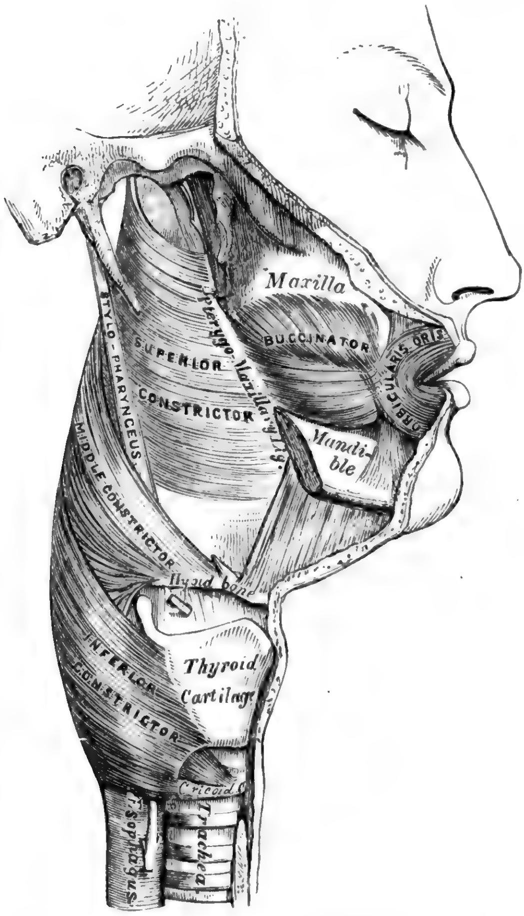
Actions.—*Geniohyoglossus,* hinder part protrudes the tongue, front part retracts, middle part or nearly whole muscle depresses and makes dorsum concave; in hemiplegia the sound fibers push apex over to the paralyzed side. The *hyoglossus* and *chondroglossus* retract, depress, and make the dorsum convex; the *styloglossus* draws the tongue back, elevates the base, and makes the dorsum concave.

The Muscles of the Pharynx

There are two layers—an outer, called the *constrictors,* three in number, with a transverse direction; an inner, called the *elevators,* two in number, with a longitudinal direction.

Inferior Constrictor (laryngopharyngeus).—**Origin,** cricoid cartilage at the lower and back part, the inferior cornu, oblique line, and upper tubercle of the thyroid cartilage; some fibers continue into it from the sternothyroid and cricothyroid muscles. It unites with its fellow in the median line; its inferior fibers are horizontal, and a few enter the longitudinal layer of the esophagus, and the highest end on a raphe about 1 inch below the basilar process. Superficial fibers of one side become deep in the other, or may join the fibers of another constrictor. This covers the middle constrictor; the superior laryngeal

FIG. 28



Muscles of the pharynx. External view.

nerve and vessels enter the larynx above its upper border, and the inferior nerve and vessels beneath its lower border.

Middle Constrictor (hyopharyngeus).—**Origin,** large and small cornua of hyoid, from the stylohyoid ligament; fibers diverge greatly, covering nearly the whole length of the pharynx, and **meet** behind in the median line; the lowest are beneath the inferior constrictor, the highest overlap the superior constrictor, the intermediate ones are transverse. The stylopharyngeus muscle separates this from the superior constrictor.

Fibers may come from the hyoid body, tongue, or mylohyoid ridge; a frequent slip from the lateral thyrohyoid ligament is the *M. syndesmopharyngeus.*

Superior Constrictor (cephalopharyngeus).—**Origin,** side of the tongue, mucous membrane of the mouth, alveolus at the end of the mylohyoid ridge, pterygomaxillary ligament, hamular process, and lower third of the posterior margin of the internal pterygoid plate; the fibers curve back and **insert** by blending with the opposite muscle or end in the aponeurosis which fixes the pharynx to the basilar process. Of all the constrictors, only the upper half of this muscle ends in a raphe (linea alba). The upper margin curves around the levator palati and Eustachian tube; the space intervening, closed by fibrous membrane is the sinus of Morgagni.

These muscles are covered externally by dense connective tissue, which is prolonged forward to the pterygomaxillary ligament, and is continuous with the membrane over the buccinator muscle; hence it is called the *buccopharyngeal fascia.* Next come the muscular layers, next the pharyngeal aponeurosis, and next the mucous membrane.

The *M. stylopharyngeus* **rises** from the inner surface of the styloid process near the root, passes down and in under cover of the middle constrictor, joined by the palatopharyngeus, and **ends** on the superior and posterior borders of the thyroid cartilage and lateral wall of the pharynx.

The *M. palatopharyngeus* will be described with the palatal muscles.

Varieties.—Splitting or doubling or a division into three parts; supernumerary elevators are common, passing to the constrictors or fibrous wall of the pharynx; from the petrous portion or vaginal process = *petropharyngeus,* from the spine of the sphenoid = *sphenopharyngeus,* from the hamular process = *pterygopharyngeus externus,* from the basilar process = *occipitopharyngeus,* from the mastoid process (rare) = *pharyngomastoideus;* a small slip to the raphe from the pharyngeal spine = *azygospharyngeus.*

Nerves.—Pharyngeal plexus and motor fibers from the bulbar part of the spinal accessory nerve, glossopharyngeal also for middle constrictor; inferior constrictor has in addition fibers from the external and inferior laryngeal nerves. Stylopharyngeus is supplied by the glossopharyngeus.

The Muscles of the Soft Palate

The soft palate (velum pendulum palati) is continued back from the hard palate, pendulous posteriorly, prolonged in the middle into the *uvula,* and laterally into the *posterior pillars of the fauces,* which run to the side of the pharynx; another fold in front is the *anterior pillar of the fauces,* descending to the tongue; between them is the tonsil, and the constricted part between the anterior pillars is the *isthmus of the fauces.* There are five pairs of muscles—two superior, one intermediate, and two inferior.

The *palatoglossus* (constrictor isthmi faucium) occupies the anterior pillar of the fauces; at its **origin** in the anterior surface of the soft palate it is below all the other palatal muscles, and continuous with its fellow; inferiorly it **enters** the side of the tongue and joins the transverse fibers.

The *palatopharyngeus* (pharyngostaphylinus) **rises** by two layers which embrace the levator palati and azygos uvulæ; the superficial (posterior) layer is thin, the deep (anterior) layer is stronger, meets its fellow, and rises in part from the hard palate and aponeurosis of the velum; it receives one or two fibers from the cartilage of the Eustachian tube (salpingopharyngeus). It passes down in the posterior pillar, mingling with the stylopharyngeus, is **inserted** into the upper and hinder borders of the thyroid cartilage and fibrous layer of the pharynx, passing to or crossing the median line.

The *azygos uvulæ* (palatostaphylinus), supposed to be single, consists of two slips which **rise** from the soft palate and posterior nasal spine and **descend into** the uvula, separated above, united below.

Levator Palati.—**Origin,** petrous portion of the temporal bone in front of the carotid canal, from the lower margin of the cartilage of the Eustachian tube, passes forward over the superior constrictor, and is **inserted** by its forepart into the aponeurosis of the palate, and posteriorly it meets its fellow under cover of the azygos uvulæ.

Circumflex, or Tensor Palati.—**Origin**, scaphoid fossa at the root of the internal pterygoid plate, spine of the sphenoid, and outer side of the Eustachian tube; descends vertically and internally to the internal pterygoid muscle; its tendon turns around the hamular process, where there is a bursa, then passes horizontally to its **insertion** into the transverse ridge of the palate bone and aponeurosis of the soft palate.

From before backward in the soft palate are the palatoglossus, tensor palati, anterior part of the palatopharyngeus, levator palati, azygos uvulæ, posterior part of the palatopharyngeus, and mucous membrane.

Nerves.—Sources not fully determined; tensor palati through otic ganglion from the third division of the fifth; levator palati, azygos uvulæ, palatoglossus, and palatopharyngeus probably by the bulbar portion of the spinal accessory nerve through the pharyngeal plexus.

Actions.—The *constrictors* are nearly immovable behind, and so carry back the anterior wall, the hyoid bone and larynx being carried up and back by the obliquity of the two lower constrictors. The upper part of the superior constrictor cannot act directly upon the food, as it is attached at both ends to immovable parts. The *stylopharyngeus* is the chief elevator of the pharynx and larynx; the *palatoglossi* depress the soft palate, elevate the tongue, and shut off the mouth cavity from the pharynx; the *palatopharyngei* depress the soft palate, raise the pharynx, and bring the posterior pillars together; the *azygos uvulæ* raises and shortens the uvula; the *levator palati* raises the palate; the *tensor palati* tightens and supports the palate against the pull of other muscles and opens the Eustachian tube in deglutition. Some hold that the tube is closed in deglutition by the levator palati pressing its floor against its upper and outer wall. The *first stage of deglutition* is effected by the mylohyoid, styloglossus, and palatoglossus pressing the tongue against the palate; the hyoid is also raised by its elevators; the larynx is then carried up beneath the hyoid by the thyrohyoid and stylopharyngeus, the root of the tongue is drawn back by the styloglossi and the epiglottis pressed down; at the same time the soft palate is raised and fixed by its proper muscles; the posterior pillars and uvula shut off the posterior nares, and the food is guided into the lower pharynx, where it is grasped by the constrictors in succession and forced into the esophagus.

II. THE DEEP NECK MUSCLES

These are divided by the transverse process into two groups. The outer from the processes to the ribs corresponding to the intercostals, those from the processes to the shoulder blade corresponding to the serratus magnus; the inner group passes from one process to another, long or short.

Outer Group (four in number).—1. *M. Scalenus Anticus.*—**Origin,** anterior tubercle of the transverse process of the third, fourth, fifth, and sixth cervical vertebræ; **insertion,** by a thick flat tendon into the scalene tubercle of the first rib; the pleura is attached to the lower part of the inner surface of this muscle.

2. *M. Scalenus Medius.*—**Origin,** tendinous above, muscular below, from posterior tubercle of transverse process of all the cervical vertebræ (sometimes not of the atlas); **insertion,** upper edge and outer surface of the first rib from the tuberosity to the subclavian groove.

3. *M. Scalenus Posticus* (smaller than the others).—**Origin,** by two or three tendons from the posterior tubercles of the lower two or three cervical vertebræ; **insertion,** by an aponeurotic tendon into the second rib external to the serratus posticus superior.

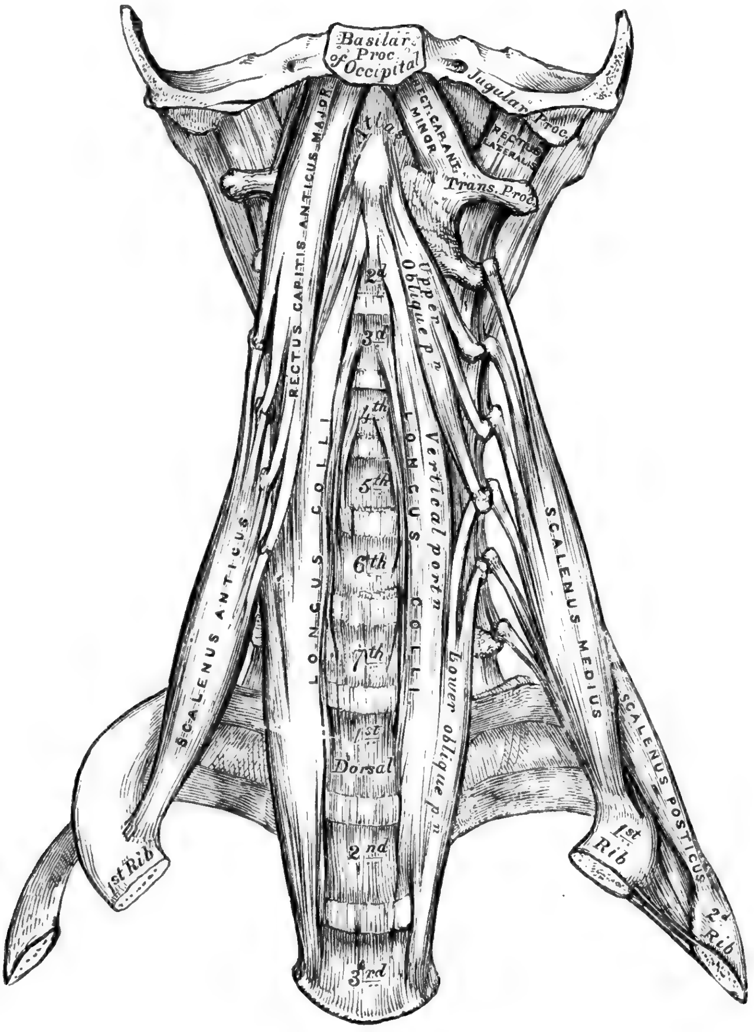
Some regard the scalenus mass as one muscle with three insertions.

4. *M. Levator Scapulæ* (levator anguli scapulæ).—**Origin,** by distinct slips from the transverse process of the upper four cervical vertebræ between the attachments of the splenius and scaleni; **insertion,** posterior border of the scapula from the spine to the superior angle.

Vertebral attachments various; a slip to it from the occipital bone or mastoid process; parts from the vertebræ may remain separate to their insertion. In quadrupeds it unites with the serratus anticus (magnus), and forms one muscle; may send a slip to the scaleni, trapezius, serrated muscles, or first and second ribs.

Inner Group.—**Long Muscles.**—1. *M. longus colli* rests on the front of the vertebral column from the atlas to the third dorsal vertebra. There are three sets of fibers: (*a*) *Vertical part,* **from** the bodies of the lower two cervical and upper two

FIG. 29



The prevertebral muscles.

or three dorsal; on its outer border it receives slips from the lower three or four cervical transverse processes; **inserted** into the bodies of the second, third, and fourth cervical vertebræ;

(*b*) *lower oblique part*, **from** the bodies of the upper two or three dorsal **into** the anterior tubercles of the fifth and sixth cervical transverse processes; (*c*) *upper oblique part* is the musculus longus atlantis of Henle. **Origin,** anterior tubercle of the transverse process of the third, fourth, and fifth cervical vertebræ; **inserted** into the vertical portion and lateral and lower part of the anterior tubercle on the arch of the atlas.

2. *M. Longus Atlantis* (see preceding muscle).

3. *M. Longus Capitis, p. n.* (rectus capitis anticus major).—**Origin,** anterior tubercle of the transverse process of the third, fourth, fifth, and sixth cervical vertebræ; **insertion,** basilar process of the occipital in front of the foramen magnum; it may show a tendinous intersection anteriorly; the pharynx is closely attached to it.

Short Muscles.—1. *Mm. Intertransversarii Anteriores.*—Anterior intertransverse muscles pass as little fasciculi between the anterior tubercles of the transverse processes of the cervical vertebræ; they are in front of the nerve trunks. The one for the axis is inserted broadly into its transverse process. They may be lacking for the two upper vertebræ.

M. Rectus Capitis Anticus, p. n. (rectus capitis anticus minor).—**Origin,** front of root of the transverse process of the atlas; **insertion,** basilar process, between foramen magnum and rectus major, $\frac{1}{2}$ inch from its fellow.

Nerves.—Rectus anticus minor by the first cervical nerve; scaleni and long prevertebral muscles by neighboring nerves; the levator scapulæ by the third, fourth, and fifth cervical nerves.

Actions.—The *scalene muscles* are elevators of the ribs, muscles of inspiration; fixed at the ribs are lateral flexors of the neck, or both sides together bend it forward; the *recti antici* flex the head and throw forward the pharynx; the *longus colli* flexes the neck, and its oblique parts may rotate; the *levator scapulæ* elevates the superior angle and base of the scapula, counteracting the rotation of the trapezius; fixed below, draws the neck back and to one side.

THE MUSCLES OF THE HEAD

These belong to the skull and face; those of the face are in three groups and in three layers.

THE EPICRANIAL MUSCLES

M. Epicranius, p. n. (occipitofrontalis), comprises the occipital and frontal muscles on either side, united by the *galea aponeurotica, p. n.* (epicranial aponeurosis). This covers the upper surface of the skull without division, closely **attached to** integument and loosely to pericranium. Behind, it is attached to the occipitales muscles, to the occipital protuberance, and supreme curved lines; it **terminates anteriorly in** the frontales; laterally has no distinct margin, but beneath it a thin fascia springs from the superior temporal line and passes under the auricular muscles to the pinna. The *frontalis muscle* (musculus epicranialis frontalis) **rises** from the aponeurosis between the coronal suture and the frontal eminence; inferiorly it **ends in** subcutaneous tissue at the root of the nose (pyramidalis nasi is a part of it, Henle), inner canthus of the eye, and whole length of the eyebrow, continued into the pyramidalis nasi and interlacing with the corrugator supercilii and orbicularis; the margins of the right and left are united near the root of the nose, but separated higher up.

The *occipitalis muscle* (musculus epicranialis occipitalis) is **attached to** the outer two-thirds of the superior curved line and to the mastoid process; its fibers, 1 to 2 inches long, **terminate in** tendon, and that in aponeurosis; an interval between the muscles is occupied by aponeurosis.

Henle describes the *auricular muscles* as a part of the epicranius; the *musculus epicranialis temporalis* is the auricularis anterior of Quain; **rises** from the root of the zygoma and bony external auditory meatus; connected with the helix and capsule of the lower jaw, its fibers **pass** up and forward to the edge of the frontalis muscle and orbicularis oculi, and meet the platysma below.

The *musculus* (*epicranialis*) *auricularis superior* **rises** from the galea aponeurotica, and **converges to** the helix by one tendon, and by another to an eminence on the inner surface of the pinna.

The *musculus* (*epicranialis*) *auricularis posterior* **rises** from the mastoid, sternomastoid aponeurosis, and outer part of the superior curved line, and is **inserted** into the vertical ridge at the back of the concha. All of the ear muscles are more or less connected.

Actions.—The *frontales* elevate the eyebrows, draw the scalp forward, and wrinkle the forehead transversely; *occipitales* draw the scalp back or may alternate with the frontales. Most persons have only partial control, best in case of frontales. The actions of the *ear muscles* are slight or nil; the anterior makes tense the temporal fascia, and has no effect on the ear; they may enlarge the entrance to the external ear.

THE MUSCLES OF THE EYELIDS AND EYEBROWS

M. orbicularis oculi, p. n., has three parts, is thin and elliptical, covers the eyelid, and extends some distance on the forehead, temple, and cheek.

The *pars palpebralis, p. n.*, is contained in the eyelids, **rises** from the upper and lower margins of the internal tarsal ligament, and passes out in a slight curve **to** the external tarsal ligament. A thicker fasciculus along the free margin of each lid is the *ciliary bundle.*

The *pars orbitalis, p. n.*, is larger and stronger, **attached to** the nasal process of the superior maxilla, inner part of the orbital arch, and externally to the cheek, forming a series of concentric loops. The *musculi malaris* of Henle are the lower converging fibers of the orbital part, passing to the skin of the cheek and muscles of the upper lip.

The *pars lacrymalis, p. n.* (tensor tarsi or Horner's muscle), extends **from** the lacrymal crest behind the sac, and **divides into** two slips behind the lacrymal canals for the ciliary bundles of the orbicularis.

The *internal palpebral ligament* (tendo oculi) is 2 lines long and **attached to** the nasal process of the superior maxilla in front of the lacrymal groove; thence it **passes to** the inner commissure of the eyelids, splitting and terminating on the tarsi; it crosses the lacrymal sac in front, and gives off a process which passes behind the sac to the crest of the lacrymal bone.

The *external palpebral ligament* is weaker, and attaches the lid to the malar bone.

The *corrugator supercilii* (described by Henle as a part of the orbicularis) **rises** from the glabella, and passes up and out to **end** at the middle of the orbital arch in the orbicularis and skin of the eyebrow.

The *levator palpebræ superior* will be described with the orbital muscles.

Actions.—Palpebral part closes the lids; upper half of the orbital part depresses the eyebrow and opposes the frontalis, used in forcible closure of the lids; in common winking the palpebral part carries forward the internal palpebral ligament and anterior wall of the lacrymal sac, and sucks in tears; the pars lacrymalis (tensor tarsi) probably alternates with the palpebral part, draws back the palpebral ligament, and compresses the sac. The *corrugator* produces vertical wrinkles at the inner end of the eyebrow.

THE MUSCLES OF THE FACE

Only one of these, the buccinator, will be described. All the others are unimportant.

M. buccinator (trumpet muscle), a flat layer forming a large part of the wall of the mouth; **attached** at the upper and lower margins to the alveoli of the maxillary bones opposite the molar teeth, posteriorly to the pterygomaxillary ligament, separating it from the superior constrictor of the pharynx, fibers become thickened at the angle of the mouth and join the orbicularis; higher and lower fibers are directed to corresponding lips, middle ones decussate, the upper to the lower lip, the lower to the upper lip.

Nerve supply is from the facial.

Action is to flatten the cheek, keep food between the teeth, and to expel air from the mouth.

THE MUSCLES OF THE ORBIT

There are seven for description. The *M. levator palpebræ superioris* (**origin,** above the optic foramen and superior rectus) ends in a membranous expansion; **inserted** into the fibrous tarsus of the upper eyelid.

The *four straight muscles* have a continuous tendinous **origin** at the apex of the orbit from a ligamentous ring which encircles the optic foramen and crosses the sphenoidal fissure; most of the fibers spring from two *common tendons;* the upper one rises from the inferior root of the small wing of the sphenoid, and is prolonged into the internal, superior, and external recti; the lower (Zinn) rises from the body of the sphenoid and divides into three slips for the internal, inferior, and external recti. All the recti are **inserted** into the sclerotic 3 or 4 lines from the cornea; the external has two heads, between which pass the third, nasal branch of the fifth, the sixth nerve, and ophthalmic vein. The external and inferior recti are the longest, internal broadest, and superior smallest.

The *superior oblique,* or *trochlearis,* is internal to the levator palpebræ, rises just in front of the optic foramen, and passes forward to a round tendon which plays through a fibrocartilaginous ring attached to the trochlear fossa of the frontal; it is there bent out, back, and down between the superior rectus and eye, and is **inserted** beneath the outer edge of the superior rectus midway between the cornea and optic nerve. The pulley is lined with a synovial sheath.

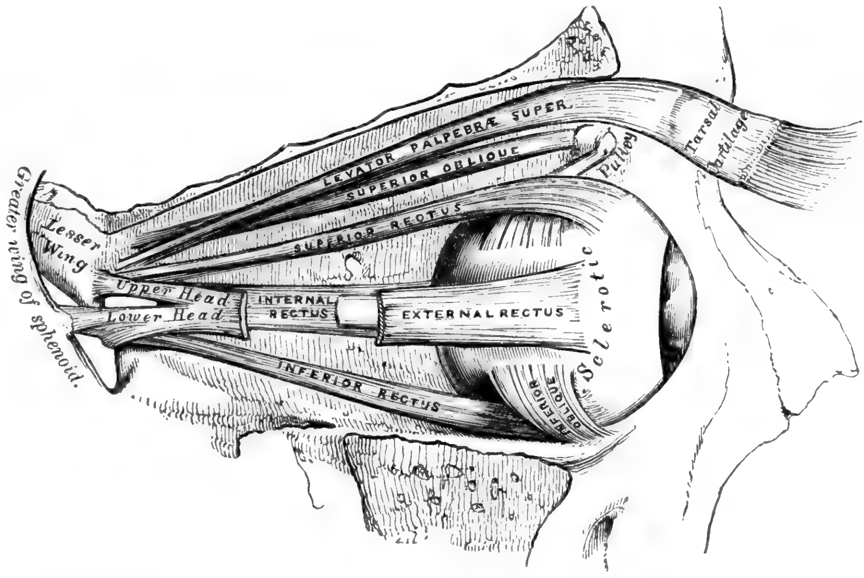
The *inferior oblique* **rises** from the orbital plate of the superior maxilla close outside the orifice of the nasal duct; the muscle passes out, back, and up between the inferior rectus and floor of the orbit, and is **inserted** under cover of the external rectus at the back part of the eyeball, nearer the optic nerve than at the cornea.

Nerves.—External rectus by the sixth nerve, superior oblique by the fourth, and the other five by the third nerve.

Actions.—*Levator palpebræ* is the elevator of the upper lid and antagonist of the palpebral part of the orbicularis. The eyeball seems to move on a central fixed point without shifting its place as a whole within the orbit; four movements are possible: (1) Lateral; (2) elevation and depression; (3) oblique movements of elevation and depression; (4) rotation about a sagittal axis. The *external* and *internal recti* produce only lateral movements; the *superior* and *inferior recti* have their line of direction internal to the centre of motion, and so produce not only elevation and depression, but also inward direction and slight rotation; this is corrected by the oblique muscles, the *inferior oblique* being associated with the superior rectus, and *superior oblique* with the inferior rectus; the superior oblique turns the cornea down and out, the inferior up and out.

Around the orbit are soft fat and the *capsule of Ténon,* forming a socket attached in front to the ocular conjunctiva; a

Fig. 30



Muscles of the right orbit.

large lymph space is between it and the eye; it is pierced by the eye muscles and sends a tubular prolongation upon each. The *suspensory ligament* of the eye is a thickening of the lower part of the capsule, attached at each end to the orbital margins and supporting the eye in its socket.

THE MUSCLES OF MASTICATION

There are four pairs, two outside and two inside the jaw bone. The *masseteric fascia* is a part of the deep cervical, covers the masseter muscle, invests the parotid gland (parotid fascia), and forms the stylomaxillary ligament.

1. *M. masseter,* a quadrate muscle with two parts; the *superficial part* is the larger and **rises** by an aponeurosis from the

malar process of the superior maxilla, and lower border of the zygomatic arch for its anterior two-thirds by tendinous bundles which project between the muscular fasciculi; it passes down and back **to** the lower half of the jaw from the angle to the third molar tooth; the *deep part* is triangular, and passes yearly vertically **from** the posterior third of the zygoma, lower border, and from all the deep surface of the arch; **inserted,** after uniting with the superficial part, into the upper half of the ramus and coronoid; this is almost wholly covered by the superficial portion.

There may be a bursa between these two parts.

The *buccal fat pad* is between the forepart of the masseter and the buccinator, and is prolonged into the zygomatic fossa; it is well developed in the infant, and inappropriately called the "sucking pad."

The *temporal fascia* is a dense aponeurosis covering the temporal muscle above the zygoma; it is attached to the temporal crest of the frontal and upper temporal line, and below divides into two layers attached to the inner and outer surfaces of the zygomatic arch; it is separated from integument by a lateral projection of the galea aponeurotica, and by the superior and anterior auricular muscles.

2. *M. temporalis* **rises,** fan-shaped, **from** the whole of the temporal fossa (not its anterior malar wall), which is covered with fat, from the deep surface of the temporal fascia, and may blend with some deep fibers of the masseter. The anterior fibers are nearly vertical, the posterior nearly horizontal; all converge to a tendon which is **inserted** into the posterior and anterior borders of the coronoid process, and deeper fibers have a fleshy insertion into its inner surface as far as the union of the ramus and body of the jaw.

3. *M. pterygoideus externus* occupies the zygomatic fossa, and **rises** by two heads, the upper and smaller from the zygomatic surface of the great wing of the sphenoid and infratemporal crest or pterygoid ridge; the lower and larger from the outer surface of the external pterygoid plate. The fibers from both pass back, **converging** to a fossa on the front of the neck of the lower jaw, to the interarticular cartilage and capsule. A venous plexus is between its upper surface and base of the skull.

4. *M. pterygoideus internus* **arises** also by two heads—one from the pterygoid fossa, the greater portion from the inner surface of the external plate, from the tuberosity of the palate bone between the two plates; a second small slip outside of the external pterygoid muscle from the tuberosities of the palate and superior maxilla; the fibers pass downward, backward, and outward to be **inserted** into the inner surface of the ramus of the mandible, between its angle and dental foramen; it is disposed in a way corresponding to the insertion of the masseter on the outer surface of the mandible near the angle.

Nerves.—All from the inferior maxillary division of the fifth cranial.

Actions.—Masseter, temporal, and internal pterygoid elevate the lower jaw; the external pterygoid protrudes the lower jaw, or alternately produces a grinding of the molar teeth; it may also assist in opening the mouth when the condyles are carried forward upon the articular eminences. The back part of the temporal and the deep part of the masseter retract the jaw.

THE MUSCLES AND FASCIÆ OF THE TRUNK

THE MUSCLES OF THE NECK AND BACK

The fascia covering the first layer of muscles is divided into a superficial and deep layer.

The *superficial fascia* is found beneath the skin. Contains considerable adipose tissue and is continuous with the superficial fascia covering the rest of the body.

The *deep fascia* is a thick fibrous layer, which covers over and forms sheaths for the muscles. It is attached to the occipital bone, the crest of the ilium, the spines of the vertebræ, and the spine of the scapula. In the neck it forms the posterior portion of the deep cervical fascia; in the thorax it blends with the axillary fascia and deep fascia of the thorax; it is continuous with abdominal fascia surrounding the muscles; forms the dorsal layer of the lumbar fascia, and covers the erector spinæ mass of muscles. In the back of the thorax it is called the *vertebral aponeurosis*.

First Layer.—1. *Trapezius* (cucullaris), or *hood muscle.*—**Origin,** inner third superior curved line of occipital bone, ligamentum nuchæ, spinous processes of the seventh cervical, and of all the dorsal vertebræ and supraspinous ligament; **insertion,** fibers converge to shoulder girdle; superior ones to outer third or half of posterior border of clavicle; middle fibers horizontally to inner margin of acromion and superior lip of scapular spine; inferior fibers up and out to a triangular tendon gliding over the inner extremity of the spine of the scapula and inserted into a tubercle on its upper lip. The aponeuroses of the two muscles form an ellipse widest at the seventh cervical spine.

2. *M. Latissimus Dorsi,* broad and flat at its origin, narrow at its insertion.—**Origin,** spinous processes of the lower six or seven dorsal vertebræ, posterior layer of the lumbar aponeurosis which attaches it to the lumbar and sacral spines and iliac crest, from the external lip of the iliac crest in front of the lumbar aponeurosis; from the last three or four ribs by digitations interposed between those of the external oblique; often by a slip from the inferior angle of the scapula. Its upper fibers are nearly horizontal, middle oblique, and the lower vertical; it winds around the teres major and in front of it, and is **inserted** by a tendon $1\frac{1}{2}$ inches wide into the floor of the bicipital groove, a little higher than the teres major, and by its upper edge into the inner lip of the groove limiting the insertion of the subscapularis.

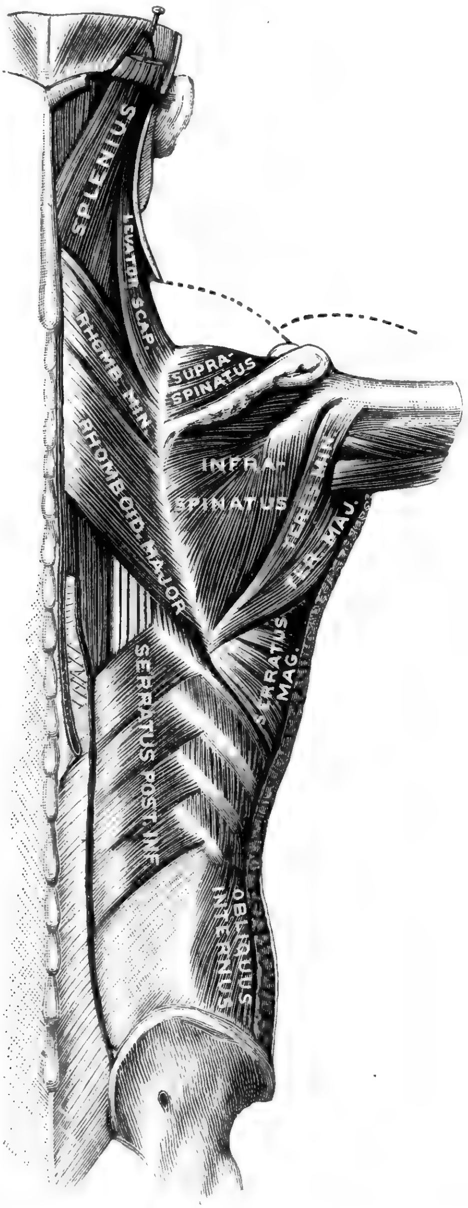
Second Layer.—1. *M. Rhomboideus Minor.*—**Origin,** seventh cervical and first dorsal spines and ligamentum nuchæ of that region; **insertion,** vertebral margin of scapula opposite triangular surface at commencement of the spine.

2. *M. Rhomboideus Major.*—**Origin,** spinous processes of four or five upper dorsal vertebræ and supraspinous ligament; **insertion,** vertebral margin of scapula between the spine and the inferior angle. The greater part of its fibers are not fixed directly to bone, but end in a tendon attached to the lower angle of the scapula, so that the muscle acts more especially upon this angle.

3. *Levator Angulis Scapuli.*—**Origin,** by tendinous slips from the transverse process of the atlas, the posterior tubercles of the transverse processes of the second, third, and fourth cervical vertebræ; **insertion** into the posterior border of the

scapula, between the superior angle and the triangular smooth surface at the root of the spine.

Fig. 31



Muscles in the second layer of the back and on the dorsum of the shoulder. (Testut.)

Third Layer.—*Serrati Muscles.*—1. *M. Serratus Posticus Superior.*—**Origin,** by a thin aponeurosis from two, rarely three, upper dorsal spines, supraspinous ligament, seventh cervical spine, lower part of ligamentum nuchæ; fibers pass down and out; **inserted** by four slips into the upper border and outer surfaces of the second, third, fourth, and fifth ribs beyond their angles.

2. *M. Serratus Posticus Inferior* (broader than the above).—**Origin,** by part of the lumbodorsal aponeurosis from first two lumbar and last two or three dorsal spines; passing up and out; **inserted** by four slips into the lower borders of the last four ribs up to the origin of the latissimus dorsi.

3. *Mm. Splenii.*—Named from strap-like action binding down underlying parts; rise from lower half of neck and upper half of back.

(*a*) *M. Splenius Capitis.*—**Origin,** ligamentum nuchæ over third, fourth, fifth, and sixth cervical spines, from seventh cervical and first two dorsal spines; **insertion,** outer surface and posterior margin of mastoid process, outer part of superior curved line to insertion of trapezius.

(*b*) *M. Splenius Cervicis* (colli).—**Origin,** below the above from the third, fourth, fifth dorsal spines, not lower than the sixth; **insertion,** with slips of the levator anguli scapulæ into the tips of the transverse process of the first and second, often third, cervical vertebræ.

The splenii are covered in part by the trapezius, rhomboidei, and superior serratus; the complexus comes to view internal to them.

Nerves.—Trapezius by the spinal accessory, third, and fourth cervical nerves; rhomboidei by the fifth cervical nerve; teres major by the lower subscapular nerve (sixth and seventh cervical); latissimus dorsi by the long subscapular nerve (seventh and eighth cervical); the serrati by the intercostals or the upper slip of the serratus posticus superior by the cervical plexus; the splenii by the posterior spinal nerve.

Actions.—*Trapezius,* upper part supports shoulder, raises point of the shoulder by rotation of the scapula, acts in forced respiration; middle part adducts the scapulæ, helps elevate the shoulder, throws the chest out; inferior part would alone depress and carry the scapulæ in, but in concert with the upper two-thirds of the muscle it raises the acromion and carries the lower angle out and up. Fixed below, one acting, draws the head back and rotates the face to the opposite side; both acting, draw the head back. The *rhomboidei* are special antagonists of the serratus magnus; they elevate the superior angle of the scapula and counteract the rotation of the trapezius; combined with the trapezius, the scapula is raised without rotation or drawn back and in. *Levator anguli scapuli* raises the angle of scapula, and assists the trapezius in bearing weights and shrugging the shoulders. If the shoulder be fixed the levator anguli inclines the head to the same side, also rotating it in a similiar direction. *Latissimus dorsi*, fixed at humerus, draws the body forward as in using crutches or climbing, feebly in forced respiration; fixed below, carries the elevated arm down, back, and rotates in; draws the shoulder down and back, is used in swimming; keeps the inferior angle of scapula close to the chest wall.

Serratus posticus superior, muscle of forced inspiration; *serratus posticus inferior*, muscle of forced expiration (Quain says of inspiration, as it holds the lower ribs fixed when the diaphragm tends to draw them up).

Splenii of one side draw the head and neck back and rotate the face to the same side; help keep the head erect.

The **vertebral aponeurosis** consists of longitudinal and transverse fibers; above, it passes beneath the serratus posticus superior and splenius muscles, to blend with the deep cervical fascia; below, it is continuous with the intercostal fascia; internally attached to the spinous processes of the thoracic vertebræ; externally, to the angle of the ribs.

The **lumbar fascia** is the same as the posterior aponeurosis covering the transversalis abdominis muscle and is divided into three layers: The *dorsal* layer is attached to the spines of the lumbar and sacral vertebræ, and their supraspinous ligaments; the *middle* layer to the tips of the transverse processes, and intertransverse ligaments of the lumbar vertebræ; the *ventral* layer, to the roots of the transverse processes of the lumbar vertebræ.

Fourth Layer.—*M. Sacrospinalis, p. n.*[1] (erector spinæ).—**Origin,** lowest two or three dorsal, all the lumbar and sacral

[1] A commission of anatomical nomenclature has suggested for universal use names here marked *p. n.* (proposed name). It is practically the nomenclature of Henle.

spines, posterior fifth of inner lip of the iliac crest, lower and back part of the sacrum, anterior surface of the lumbar fascia; opposite the last rib this mass divides into the middle and outer columns, and an inner one, *spinalis dorsi,* separates from the middle in the upper dorsal region. The outer and middle portions subdivide.

I

(*a*) Middle column.	(*b*) Outer column.
Longissimus dorsi (Longissimus dorsi, *p. n.*).	Sacrolumbalis (Iliocostalis lumborum, *p. n.*).
Transversalis cervicis (Longissimus cervicis, *p. n.*).	Musculus Accessorius (Iliocostalis dorsi, *p. n.*).
Trachelomastoid (Longissimus capitis, *p. n.*).	Cervicalis ascendens (Iliocostalis cervicis, *p. n.*).

(*c*) Inner column.

Spinalis dorsi.	Spinalis colli or cervicis.

II

Complexus.

M. iliocostalis lumborum (sacrolumbalis) **from** the outer and superficial portion of the common mass **into** the angles of the lower six or seven ribs.

M. iliocostalis dorsi (accessorius), **from** ribs into which the preceding is inserted, but internal to it, into the angles of the upper six ribs and transverse process of the seventh cervical vertebra.

M. iliocostalis cervicis (cervicalis ascendens) continues the series **from** the angles of the upper four or five ribs **into** the posterior tubercles of the fourth, fifth, and sixth cervical transverse processes.

M. longissimus dorsi **rises** from the common mass, has **two sets of insertions**—the inner row of round tendons into all the dorsal transverse processes and lumbar accessory processes; an outer row to the lowest nine or ten ribs between the angles and tuberosities, and to the whole length of the lumbar transverse processes and into the lumbar fascia.

M. longissimus cervicis (transversalis cervicis), **from** the highest four or five dorsal transverse processes **into** posterior tubercles of the transverse processes of the five cervical vertebræ, second to sixth inclusive.

M. longissimus capitis (trachelomastoid), by four tendons **from** the upper dorsal transverse process, and **from** the articular process of the lower three or four cervical vertebræ, **into** the posterior margin of the mastoid process under the splenius capitis and sternomastoid. It shows a tendinous intersection near its insertion; it is the only muscle between the splenius and complexus.

Musculi spinales, spinous muscles, have an arched direction. 1. *M. spinalis dorsi,* close inside the longissimus dorsi and connected with it; **origin,** lowest two or three dorsal spines and from tendons passing from the upper lumbar spines to the longissimus dorsi; **inserted** by four to nine slips into the upper dorsal spines.

2. *M. spinalis cervicis,* inconstant or different on the two sides **from** the ligamentum nuchæ and seventh cervical spine, and one or two above or below this; **inserted** into the spine of the axis or also into the third and fourth cervical spines.

Complexus Muscle.—**Origin,** from the tips of the transverse processes of the upper six or seven thoracic and the last cervical vertebræ, and from the articular processes of the fifth, sixth, and seventh cervical vertebræ; forming a broad muscle, which is inserted into the innermost depression between the two curved lines of the occipital bone.

Fifth Layer.—(*a*) *Mm. Semispinalis* (half-spinous).—(1) *M. semispinalis dorsi,* by five or six tendons **from** the transverse process of the dorsal vertebra, from the sixth to the tenth inclusive; **inserted** by just as many tendons into the spines of the upper four dorsal and lower two cervical vertebræ. (2) *M. semispinalis cervicis,* covered by the complexus, **rises** nearly from the insertion vertebræ of the preceding, viz., upper five or six dorsal transverse processes; **inserted** into the cervical spines from the second to the fifth, inclusive, being thickest into the axis. (3) *M. semispinalis capitis* (complexus) **rises** by two sets of heads; the inner, or *biventer cervicis,* **rises** *from* three or four dorsal transverse processes between the second and sixth; its superficial fibers are **inserted** into the external occipital protuberance beside the ligamentum nuchæ; its deeper fibers join the external head. The outer head **rises**

from the upper dorsal and lower three or four cervical vertebræ, on the dorsal and seventh cervical from the transverse process, on the remaining cervical vertebræ (fourth, fifth, or sixth) by two slips from each, one from the posterior tubercle of the transverse process, and one from the lower articular process. These fibers unite, join part of the inner head, and are **inserted** into the inner impression between the two curved occipital lines. A tendinous inscription crosses the muscle near the spine of the axis; another crosses the biventer lower down.

(*b*) *M. multifidus spinæ* occupies the groove beside the spinous processes from the sacrum to the axis; **rises** *from* the deep surface of the erector spinæ, from the back of the sacrum as low as the fourth foramen, posterior extremity of the ilium, and posterior sacroiliac ligament; in the lumbar region from the mammillary processes; in the dorsal, from the transverse process; in the cervical, from the articular processes of the four lower vertebræ. The bundles pass up and in, to be **inserted** into the whole length of the spines from the last lumbar to the axis; some fibers go to the fourth vertebra above, others to those nearer.

(*c*) *Mm Rotatores.*—1. *Mm. rotatores longi,* really a part of the multifidus, only in the dorsal region, **from** the upper edge of a transverse process **into** the lateral edge of the root of the second or third spinous process above.

2. *Mm. rotatores breves* (rotatores dorsi of Quain), eleven in number, dorsal region, nearly horizontal, **from** the upper edge of a transverse process **into** the lower edge of the lamina above.

Of Flexion Vertebræ.—Mm. interspinales, vertical sets of fibers in pairs between contiguous spinous processes; in the neck they are round, in the back are usually absent, in the loins are flat from side to side.

Mm. Intertransversales (*posteriores,* as there is also an anterior set in the neck).—In the lumbar region there are two parts—an inner, *intertransversalis posticus medialis,* **from** a mammillary process **into** an accessory or mammillary process next above; an external, *intertransversalis posticus lateralis,* between two contiguous transverse processes. In the back the inner portion is supplied by the intertransverse ligaments, the outer portion by the levator costarum; in the neck and upper dorsal region they are single bands between the transverse process and behind the cervical nerves.

Short Muscles of Rotation Vertebræ and Occiput.—Five on each side; two rise from the axis and three from the atlas. (1) *M. rectus capitis posticus major.*—**Origin,** spine of the axis, upper border; **insertion,** into and below the middle third of the inferior curved line of the occiput. (2) *M. obliquus capitis inferior,* strongest of these muscles.—**Origin,** upper and posterior part of the arch of the axis (Henle); **insertion,** back part of the transverse process of the atlas. (3) *M. rectus capitis posticus minor.*—**Origin,** posterior tubercle of the atlas; **insertion,** into and beneath the inner third of the inferior curved line of the occiput, covered partly by the major muscle. (4) *M. obliquus capitis superior.*—**Origin,** upper surface of transverse process of the atlas; **insertion,** impression between the outer parts of the occipital curved lines. (5) *M. rectus capitis lateralis.*—**Origin,** anterior surface of the apex of the transverse proces of the atlas; passes nearly straight up **to** the jugular process of the occiput.

The two oblique muscles, with the rectus capitis posticus major, form the *suboccipital triangle,* in which are found the vertebral artery and the posterior primary branch of the suboccipital nerve (Quain).

The **extensor coccygeus** is a slender fasciculus, occasionally present, which extends over the lower part of the posterior surface of the sacrum and coccyx. It arises by tendinous fibers from the last bone of the sacrum or first piece of the coccyx, and passes downward to be inserted into the lower part of the coccyx. It is a rudiment of the extensor muscle of the caudal vertebræ of the lower animals (Gray.)

Nerves.—All of the foregoing muscles of the neck and back are supplied by posterior primary branches of the spinal nerve.

Actions.—The longitudinal muscles extend the back with a force of 200 to 400 pounds; some of the lower muscles may depress the ribs and aid in forced expiration; some of the upper, if fixed above, may act in forced inspiration. The muscles of one side produce lateral flexion of the spinal column. The *complexus* and *transversospinalis* rotate the head and spine to the opposite side. The *rectus minor* and *superior oblique* chiefly extend the head; the *rectus major* and *inferior oblique* rotate the atlas and skull on the axis; the *major* also extends the head. The *levatores costarum* have but little action on the ribs; are regarded as muscles of forced inspiration. The *rectus lateralis* bends the head to one side.

THE FASCIÆ AND MUSCLES OF THE ABDOMEN

The fascia of the abdomen is divided into a **superficial**, and a **deep** aponeurosis. The **superficial fascia** is subdivided into a superficial layer and a deep layer.

The *superficial layer* of the superficial fascia (Camper's fascia) is continuous with the fascia over the thorax, back, and thighs, and in the male it passes over the penis and outer surface of the cord to the scrotum, helping to form the dartos; from here it is traced backward as the superficial layer of the superficial fascia of the perineum; in the female it passes to the labia majora. The *deep layer* of the superficial fascia (Scarpa's fascia) is continued above with the superficial layer of the superficial fascia; it is adherent internally to the linea alba and symphysis pubis; below it forms the suspensory ligament of the penis and laterally passes over Poupart's ligament to blend with the fascia lata of the thigh; at the root of the penis it passes over the latter organ and the scrotum and cord to help form the dartos. At the margin of the dartos it is continuous with the deep layer of the superficial fascia of the perineum (Colles' fascia); in the female it is continuous with the labia majora.

The deep abdominal fascia covers the aponeurosis of the external oblique muscle, but is so closely adherent that it is difficult of demonstration.

1. *M. rectus abdominis,* separated from its fellow by the linea alba.—**Origin,** cartilage of the fifth, sixth, and seventh ribs, and usually bone of the fifth, by three slips, sometimes from the ensiform; **insertion,** by two tendons, the inner smaller one into the front of the symphysis pubis, crossing its fellow of the opposite side, passing down and out to the adductor fascia, down and in to the fascia of the penis; the outer head into the pubic crest or space in front of it if the pyramidalis is lacking. (Henle considers the insertion as below, as it passes into so much movable fascia.) The fibers are interrupted by zigzag transverse tendinous intersections, linea transversæ.

2. *M. pyramidalis* rests on the lower part of the rectus inside its sheath, separated from it by a special fascia. **Origin,** front of the pubis below the insertion of the outer tendon of the rectus, passes over the lower third of the space between the umbilicus and pubis; **inserted** into the linea alba. Its inner fibers are vertical, outer ones oblique.

The **linea alba** is a fibrous structure from the ensiform to the pubis, formed by the union of the oblique and transverse aponeuroses, broadest above, $\frac{1}{5}$ inch (4 to 7 mm.), and a little below its middle is the cicatrix of the *umbilicus.* At the lower end it passes in front of the recti, and here is detached posteriorly a band of longitudinal fibers = *adiminiculum lineæ albæ,* spreading out triangularly behind the outer heads of the recti.

The **linea semilunaris** is a depression seen on the outer side of each rectus abdominis muscle, and corresponds to the line of fusion of the aponeuroses of the oblique and transversalis muscles, as they blend to pass in front and behind the recti muscles to form the sheath of the latter muscles. It extends from opposite the ninth costal cartilage to the spine of the pubic bone.

Lineæ transversæ are depressions seen along the recti muscles, and correspond to the attachment of the aponeuroses of the abdominal muscles to the rectus. They are usually three—one below the ensiform cartilage, one between the ensiform and the umbilicus, and one opposite or below the umbilicus.

1. *M. obliquus externus,* or descending oblique, is muscular on the side, aponeurotic in front.—**Origin,** outer surfaces and lower borders of the lower eight ribs (seven, Henle) by slips in a serrated series, five interdigitating with the serratus magnus, the lower three with the latissimus dorsi, from the lumbo-dorsal aponeurosis connected with first lumbar vertebræ. The slip from the eighth rib is broadest, the others diminish above and below that; upper and lower digitations rise from near the costal cartilages, the intermediate ones at some distance from them.

The fibers from the last two ribs pass nearly vertically down to insert the anterior half of the outer lip of the iliac crest; all the rest incline down and forward to the *aponeurosis.* This is wider below than above, meets its fellow in the linea alba, is connected with the costoxiphoid ligament, gives origin to the lowest fibers of the pectoralis major, or is covered by a fascia derived from it; below it extends from the anterior superior spine of the ilium to the spine of the pubis as a thickened border called **Poupart's ligament.** Poupart's ligament affords attachment throughout its entire length to the aponeurosis of the external oblique muscle; its outer half gives attachment to the internal oblique and transversalis muscles.

The aponeurosis is perforated by a large opening near the pubis for the spermatic cord in the male and round ligament in the female; this is the **external abdominal ring** (annulus inguinalis cutaneus, *p. n.*). It is oval or elliptical, 1 inch long, $\frac{1}{2}$ inch wide in the male, with its base at the pubic crest; its sides are the *pillars* (crus superius and crus inferius, *p. n.*); the *upper* or *inner* is flat and straight, attached to the anterior surface of the pubis, decussating with its fellow or passing to the adductor fascia and dorsum of the penis; the *lower* or *external* is thin above, and below is formed by the inner end of Poupart's ligament, attached to the spine of the pubis. The **intercolumnar fibers** are seen passing across the two pillars of the external abdominal ring, and gives off a thin aponeurosis, which passes on to the spermatic cord, called the intercolumnar fascia.

The deepest fibers of Poupart's ligament are sent back to the inner part of the iliopectineal line for $\frac{3}{4}$ inch, forming a layer called **Gimbernat's ligament,** presenting upper and lower surfaces and a concave margin toward the femoral ring and vein. Some of the fibers of Gimbernat's ligament or of the outer pillar are reflected up and in, under the spermatic cord, behind the inner pillar, in front of the conjoined tendon, covering the posterior wall of the external ring, and pass to the sheath of the linea alba or interlace with the opposite external oblique muscle; this is the **reflected Gimbernat's ligament,** or **triangular fascia.**

Cooper's ligament, described first by Sir Astley Cooper. It extends from the base of Gimbernat's ligament along the iliopectineal line, to which it is attached. It is strengthened by the fascia transversalis, the iliopectineal aponeurosis, and by a lateral expansion from the lower attachment of the linea alba (adminiculum lineæ albæ) (Gray).

Generally the external oblique and latissimus dorsi leave a triangular space between them on the iliac crest, forming **Petit's triangle.** Thirty or forty cases of lumbar hernia protruding through this space have been recorded.

2. *M. Obliquus Internus.*—**Origin,** outer half of Poupart's ligament, anterior two-thirds of the middle ridge of the iliac crest, from the lumbar fascia; **insertion,** lower margins of the cartilages of the last three ribs, its aponeurosis, and by **conjoined tendon** (with transversalis) arching over the inguinal canal to the front of the pubis and inner part of the iliopectineal line behind Gimbernat's ligament. Sometimes the conjoined tendon divides into an outer portion, the **ligament of Hesselbach**; and an internal portion, the **ligament of Henle.** The *aponeurosis* splits at the outer border of the rectus; the anterior layer unites with the external oblique aponeurosis, the posterior with the transversalis aponeurosis, which reunite and form the *sheath of the rectus;* the posterior layer is attached above to the ensiform, seventh and eighth rib cartilages. This division of aponeurosis stops a little above half-way between the umbilicus and pubis, and below this point the internal oblique aponeurosis and transversalis aponeurosis pass wholly in front of the rectus. This deficiency in the posterior wall of the sheath is marked by a lunated edge, concave downward, the *semilunar fold of Douglas* (linea Douglasii, *p. n.*); here the rectus is separated from the abdominal contents by peritoneum, subperitoneal tissue, transversalis fascia, and a thin connective tissue which continues the transverse aponeurosis. (Note a difference between the transversalis fascia and the aponeurosis.)

The *cremaster* muscle, peculiar to the male, is attached externally to the inner portion of Poupart's ligament, and is continuous with the internal oblique fibers; its internal attachment (inconstant) is the spine and crest of the pubis; it descends in folds in front of the spermatic cord to the level of the testis, and spreads out in a *cremasteric fascia.* Some regard this muscle as a part of a fetal structure called *gubernaculum testis.* There are some remains of it in the female.

3. *M. Transversalis Abdominis.*—**Origin,** inner surface of the lower six rib cartilages, interdigitating with the diaphragm, from the lumbar transverse process by a *posterior aponeurosis,* from the anterior three-fourths of the inner margin of the iliac crest, outer third of Poupart's ligament. This muscle

nearly surrounds the abdomen, and is inserted into the *anterior aponeurosis* and *conjoined tendon.* This aponeurosis commences for the most part about 1 inch from the outer border of the rectus in the *linea Spigelii* (*p. n.*), but muscular fibers nearly meet behind the rectus above; the lower third of this aponeurosis passes in front of the rectus.

The *posterior aponeurosis* is the middle layer of the lumbar fascia or lumbocostal ligament (Henle), between the erector spinæ and quadratus lumborum muscles. The highest part of this muscle is continuous with the triangularis sterni.

Nerves.—Supplied in general by the lower intercostal nerve; internal oblique and transversalis, also by the iliohypogastric and the ilioinguinal nerves; the cremaster by the genital branch of the genitocrural nerve.

Actions.—Upon the thorax, viscera, or vertebral column; pelvis and thorax fixed, they *aid vomiting, expulsion of fetus, feces,* and *urine;* vertebral column fixed, they raise the diaphragm by pressing up the viscera, and so *aid expiration; flex the thorax* to the front or laterally, or *rotate* it if the vertebral column be not fixed; thorax fixed, *draw up the pelvis* in climbing. Pyramidales make the linea alba tense.

THE LINING FASCIÆ OF THE ABDOMEN

The **transversalis fascia** covers the inner surface of that muscle, and is continued upon the under surface of the diaphragm; along the inner margin of the iliac crest it is attached to the periosteum; for about 2 inches internal to the anterior superior iliac spine it is attached to the back of Poupart's ligament and the iliac fascia; next internally it passes down over the femoral vessels as the anterior portion of their sheath; as it passes under Poupart's ligament it is strengthened by the *deep crural arch* (arcus cruralis), a band of fibers inserted into the pubic spine and iliopectineal line behind the conjoined tendon; it includes beneath it, between the femoral vein and Gimbernat's ligament, the *femoral ring,* through which a femoral hernia may descend.

The **internal abdominal ring** is situated in the transversalis fascia, midway between the spine of the ilium and the crest of the pubic bone. It is $\frac{1}{2}$ inch above Poupart's ligament, and is the internal opening of the inguinal canal. It transmits the spermatic cord in the male, and the round ligament in the female. From its circumference a thin, funnel-shaped membrane is given off, to continue on to the cord and testes, as a distinct covering. It is called the **infundibuliform** or **internal spermatic fascia.** The ring is bounded above and externally by the arched fibers of the transversalis muscle, below and internally by the deep epigastric vessels and **Hesselbach's ligament.** In front by the internal oblique muscle.

The inguinal or **spermatic canal** contains the spermatic cord in the male, and the round ligament in the female. It is $1\frac{1}{2}$ inches in length, parallel to and $\frac{1}{2}$ inch above Poupart's ligament. It is bounded in front by the aponeurosis of the external oblique muscle, throughout its whole length, and by the internal oblique muscle over its outer third; behind, from within outward, are the triangular fascia (when present), the transversalis fascia and conjoined tendon; above by the arched fibers of the internal oblique muscle; below by Gimbernat's ligament near the external ring, and Poupart's ligament. The deep epigastric vessels and Hesselbach's ligament lie behind the middle of the canal.

Hesselbach's triangle is the interval within the transversalis fascia, bounded internally by the outer border of the rectus muscle, externally by deep epigastric artery, and the base is the inner third of Poupart's ligament.

The **iliac fascia** covers the iliopsoas muscle, stretched from the iliac crest to the iliac portion of the iliopectineal line; it is continued up on the psoas, attached to the sacrum, invertebral disks, internal arched ligament of the diaphragm, and externally to the iliolumbar ligament (anterior layer of the lumbar fascia). Below it passes beneath the femoral vessels, forming the hinder part of the femoral sheath; outside the vessels it unites with the transversalis fascia on Poupart's ligament and with the external inguinal ligament, which prolongs it to the fascia lata (iliac portion); internally it joins the pubic portion of the fascia lata. A strong band is attached to the iliopectineal eminence between the psoas and pectineus, called the *iliopectineal ligament.*

THE FASCIÆ OF THE PERINEUM

Superficial.—In the anterior half of the perineum, continuous with the dartos, is the *superficial perineal fascia,* or *fascia of*

Colles, bound to the ischiopubic rami as far back as the ischial tuberosities; on a line from this tuberosity to the central point of the perineum it turns around the transversus perinei muscle and becomes deep perineal fascia. There is an incomplete median septum, so that extravasated urine distends one side of the scrotum beneath the dartos, then penetrates to the other side, then to the front of the abdomen beneath the superficial fascia, but does not pass to the posterior half of the perineum nor down upon the thighs. *Buck's fascia* is the continuation forward of Colles' fascia, investing the penis as far as the glans, continuous with the dartos, and directing the urine as already stated.

The **deep perineal** or **subpubic fascia** or **triangular ligament of the urethra** is stretched across the subpubic arch on the deep surface of the crura and bulb, and consists of two layers; the *inferior* layer extends back to the central point of the perineum, attached to the ischiopubic rami, connected at its base with the other layer, and continuous with the recurved margin of the superficial perineal fascia. This layer, meeting from below the arcuate pubic ligament (subpubic), forms an aperture for the dorsal vein of the penis. It is perforated by the urethra, arteries of the bulb and of the corpora cavernosa, and ducts of Cowper's glands.

The *superior* (deep) layer consists of right and left lateral halves, separated in the middle line by the urethra close to the prostate, and continuous on each side with the fascia covering the obturator internus muscle. The levator ani is between this layer and the rectovesical fascia.

Between the two layers of the triangular ligament are the membranous portion of the urethra, the compressor urethræ muscle, Cowper's glands, pudic vessels, and dorsal nerves of the penis.

THE FASCIÆ OF THE PELVIS

This consists of two parts, obturator and rectovesical fascia.

The **obturator fascia** covers the inner surface of the obturator internus muscle; it is attached to the iliac portion of the ilio-pectineal line, to the body of the pubis, to the great sacrosciatic notch and great sacrosciatic ligament, and upper edge of the obturator membrane; below it joins the falciform process of the great sacrosciatic ligament and bounds the ischiorectal fossa externally. Near its upper margin it gives off the **anal** or **ischiorectal fascia,** which covers the levator ani externally and bounds the ischiorectal fossa internally.

The **fascia of the pyriformis** is continued back from the obturator in front of the pyriformis muscle and sacral plexus.

The **rectovesical fascia** is attached in front to the back of the pubis, and laterally separates from the obturator fascia along a curved line from the upper part of the obturator foramen to the ischial spine; this is the posterior part of the *white line* which extends from the pubis to the ischial spine. The fascia, covering the upper surface of the levator ani muscle, passes to the prostate gland, bladder, rectum, and from side to side across the median line. The part to the prostate and neck of the bladder from the pubis consists largely of involuntary muscular fibers, the *anterior true ligaments of the bladder,* or *puboprostatic ligaments;* outside them are the *lateral true ligaments,* and the part going to the rectum is the *ligament of the rectum.* The anterior part of the fascia meets the bladder along its junction with the prostate, and divides into two layers; the upper (ascending) unites with the muscular coat of the bladder, and is attached just outside the vesiculæ seminales; the inferior layer (descending) forms the sheath of the prostate, and at its apex is continued into the upper layer of the triangular ligament; it also passes between the bladder and rectum and forms the front of the sheath of the latter. The vagina receives the rectovesical fascia in a manner similar to the prostate.

THE MUSCLES OF THE PERINEUM IN THE MALE

Two groups—anal and genitourinary, comprising a superficial and a deep set in each.

I. The Anal Muscles

The *internal* or *circular sphincter* is a thick ring of unstriped muscle continuous with the circular fibers of the rectum.

The *external sphincter,* one inch in depth, is elliptical, **attached by** a small tendon to the coccyx, encloses the anus, and superficial fibers end in skin; some decussate across the median line; a few deep ones are continuous from side to side, but a large part blend with the muscles at the "central point."

The *central point of the perineum* is the median part of a tendinous septum in which several muscles meet; it is one inch in front of the anus, behind the bulb of the urethra; may be absent.

The *levator ani* **rises** *from* the pubic body, adherent to and between the obturator and rectovesical fasciæ, from the "white line," spine of the ischium, and the upper layer of the triangular ligament.

Insertion.—The hinder fibers pass down and in **to** the coccyx. The foremost run almost directly back to the "central point," the intervening ones to the lower end of the rectum and median aponeurosis between the coccyx and anus, common to the two muscles.

The *coccygeus*, or *levator coccygeus*, **rises** by its apex from the ischial spine and obturator fascia, and is **inserted** by its base into the margin of the coccyx and lower part of the sacrum. This with the above muscle, on both sides, constitutes the *pelvic diaphragm.*

II. The Genitourinary Muscles

Three on each side and a central deep one.

Transversus Perinei.—**Origin,** low down on inner margin of the ischial ramus passes forward and inward to **unite with** its fellow, the external sphincter, and bulbocavernosus at the "central point."

Ischiocavernosus, or Erector Penis.—**Origin,** inner margin of the ramus of the ischium, behind and on each side of the attachment of the crus penis; its tendon spreads over the crus, and is **inserted** into the outer and under sides of that body at its forepart.

Bulbocavernosus, or *ejaculator urinæ,* unites with its fellow in a median raphe continued forward from the "central point," the two covering the bulb and part of the corpus spongiosum. Its fibers ascend from the raphe and end on the dorsum of the corpus spongiosum by joining its fellow; at the forepart some pass to the outer side of the corpus cavernosum and send an expansion over the dorsal vessels; some of the posterior fibers unite with the under surface of the triangular ligament.

The above three muscles and enclosed triangular space are between the superficial and the deep perineal fasciæ, *i. e.*, below the lower layer of the triangular ligament.

The *constrictor*, or *compressor urinæ*, **rises** from the ischiopubic rami, from the two layers of the triangular ligament, between which it is placed, and **surrounds** the membranous portion of the urethra, forming a kind of sphincter. A median raphe sometimes divides the muscle. Its hindermost fibers have been described as the *transversus perinei profundus*.

Most of the fibers pass transversely, others obliquely, others circularly around the urethra, and on the inferior surface is a longitudinal slip from the base to the apex of the triangular ligament.

Nerves.—External sphincter by the fourth sacral and inferior hemorrhoidal of the pudic, levator ani by the fourth sacral and perineal branch of the pudic; coccygeus by the fourth sacral; the three superficial genitourinary muscles by the perineal branch of the pudic; constrictor urethræ by the dorsal nerve of the penis.

Actions.—*Internal sphincter* wholly involuntary, *external* usually involuntary, but made firmer by act of the will; the *levator ani* and *coccygeus* support and raise the floor of the pelvis, and thus have to do with forced expiration; the levator also assists in emptying the lower rectum, raising and expanding its aperture, but some of its fibers act with the external sphincter in closing the anus; the *transversi* fix the "central point" and give support to the ejaculator muscles; the *ischiocavernosi* compress the crus and help produce and maintain erection of the penis; the *bulbocavernosi* forcibly eject fluid mostly voluntarily at the end of micturition, involuntarily in the emission of semen; they also are supposed to aid erection of the penis; the *constrictor urethræ* assists the bulbocavernosi in clearing the urethra and erects penis. (Henle).

THE MUSCLES OF THE PERINEUM IN THE FEMALE

In the female, the *transversus perinei, external sphincter, levator ani, erector clitoridis* (ischiocavernosus) correspond to similar muscles of the male, the *sphincter vaginæ* to the bulbocavernosi. The *constrictor urethræ* is the transversus perinei profundus, and differs from that of the male by being divided into lateral halves by the vagina.

The Diaphragm (Midriff)

A partition between the abdomen and thorax, rising by muscular fibers as *vertebral, costal,* and *sternal* portions.

The **crura,** or **pillars of the vertebral portion,** connected with the anterior common ligament, **rise** from the bodies and intervertebral substance of the lumbar vertebræ, the right from the second, third, and fourth, the left from the second and third; they arch over the aorta from right to left, and meet behind it from left to right. The muscular fibers from them form a figure 8, leaving an opening for the esophagus. The *internal arcuate ligament* **passes over** the psoas muscle from the outer side of the first lumbar body to the second transverse process. The *external arcuate ligament* **passes over** the quadratus lumborum from the second transverse process to the last rib; they are the upper margins of fascia covering those muscles; an arched ligament may pass over both muscles; muscular fibers of the diaphragm rise from both.

The **costal portion** rises from the lower six cartilages, interdigitating with the transversalis abdominis. The *sternal portion* is very short—a single muscular slip, sometimes two, from the ensiform cartilage.

The **central tendon, trefoil,** forms the highest part, convex above, concave below; has three lobes, the right being the largest, the left the smallest; the tendinous fibers are interwoven in every direction.

There are **three foramina**: The *hiatus aorticus,* in front of the first lumbar, transmitting the aorta, thoracic duct, and vena azygos magnus; the *foramen for the esophagus,* opposite the tenth dorsal vertebra, entirely surrounded by muscle, oval, transmits the esophagus, pneumogastric nerves, and branches of the coronary artery; the *foramen quadratum* for the vena cava is in the highest part of the central tendon, at the level of the disk between the eighth and ninth dorsal vertebræ; its sides are firmly attached to the vein. A sterno-diaphragmatic ligament passes to this foramen.

Small foramina are in the crura for the splanchnics on both sides, for the small azygos vein on the left side; the sympathetic cord perforates the crus or passes under the internal arched ligament.

There are **four weak places**: (1) Between the costal and vertebral portions near the quadratus lumborum; (2) between the costal and sternal portions = Larrey's spaces; (3) the esophageal opening; (4) where the sympathetic cords pierce the crura. Left side, as a whole, is the weaker; at Larrey's space is peritoneum below, then areolar tissue, then pericardium on the left side and pleura on the right side.

Highest point of the diaphragm on the right side in the dead body is the level of the fifth rib cartilage with the sternum; on the left side, of the sixth cartilage with the sternum (Quain); the midportion is flat, supports the heart, and is nearly immovable. A considerable extent of the origin of the diaphragm is in contact with the thoracic wall.

Relations are, above, pleuræ and pericardium, lungs, and heart; below, peritoneum, liver, stomach, pancreas, spleen, and kidneys.

Nerves.—Phrenics, lower intercostals, and sympathetic.

Actions.—By its contraction and descent the viscera are pushed down and thorax lengthened; it elevates the ribs when its vault is supported by the abdominal viscera; its anterior fibers oppose forward movement of the sternum.

THE FASCIÆ AND MUSCLES OF THE THORACIC REGION

Fascia of Pectoral Region.—*Superficial* contains the mammary gland, sending septa into it and supporting it. These were called by Sir Astley Cooper the **suspensory ligaments.** The *deep fascia* is thin, covering the surface of the pectoralis major muscle; it is attached to the middle of the front of the sternum, above to the clavicle, and below is continuous with the fascia over the shoulder, axilla, and thorax. It encloses the space between the pectoralis major and latissimus dorsi muscles; it is called in this region the **axillary fascia.** This latter fascia sends a prolongation upward under cover of the pectoralis major muscle, called the **deep pectoral fascia.**

The **costocoracoid membrane** or **clavipectoral fascia** lies beneath the clavicular portion of the pectoralis major, bridging in the interval between the upper border of the pectoralis minor muscle and the subclavius muscles. Above it splits, and is attached to the clavicle, one layer in front of the subclavius muscle, the other layer behind it. Internally it blends with the fascia covering the first two intercostal spaces, and is also attached to the first rib, internal to the origin of the subclavius muscle. Externally it is attached to the coracoid process. This latter portion of the membrane is called the **costocoracoid ligament**, extending from the first rib to the coracoid process and blended with the subclavius muscle. Below, the costocoracoid membrane splits at the upper border of the pectoralis minor muscle, invests it, and from the lower border the single layer is continued downward to join the fascia covering the biceps muscle and axillary fascia. The cephalic vein, acromiothoracic vessels, superior thoracic artery, and external anterior thoracic nerve pierce the costocoracoid membrane. It also sends a slip upward behind the clavicle to blend with the deep cervical fascia and the sheath of the axillary vessels.

The Anterior Thoracic Region

M. pectoralis major, two portions, *clavicular* and *sternocostal;* the clavicular portion **rises** from the inner half of the anterior surface of the clavicle and sternoclavicular capsule, the sternocostal from the sternum (superficial part, Henle), from the upper six rib cartilages (deep part, Henle) and from the anterior sheath of the rectus and external oblique aponeurosis. The fibers converge to be **inserted** by two tendons, united along the lower margin, into the external bicipital ridge; the clavicular and upper sternocostal parts form one tendon with straight fibers; the lower sternocostal part twists so that its lowest fibers are inserted highest; a bursa separates this from the other anterior tendon. This posterior layer also gives off three expansions—one over the biceps tendon to the capsule of the shoulder-joint, one lining the bicipital groove, and one to the deep fascia of the arm.

1. *M. subclavius* **rises** from the groove on the under surface of the clavicle and recess between the conoid and trapezoid

ligaments; **inserted** into the junction of the first rib with its cartilage between the fibers of the costoclavicular ligament.

2. *M. pectoralis minor* **from** three ribs near their cartilages, usually the third, fourth, and fifth, often the second, third, and fourth or fifth, and from the intercostal aponeuroses; **insertion,** inner border and upper surface of the coracoid; a bursa is under its insertion (1 in 40 cases).

The Lateral Thoracic Region

M. serratus magnus, placed between the ribs and scapula. **Origin,** first eight or nine ribs by as many slips; the first slip is attached to two ribs; **insertion,** posterior border of the scapula and into the flat surfaces or anterior aspects of the upper and lower angles, not in the subscapular fossa. There are three sets of fibers: (1) First digitation from the first and second ribs, passes up to the flat area at the upper angle; (2) second and third digitations, from the second and third ribs, pass down in a thin triangular layer to the whole line between the upper and lower angles; (3) the remaining five or six digitations converge, some up and some down, to the flat surface in front of the lower angle.

Nerves.—The pectoralis major by the two anterior thoracics; the minor by the internal anterior thoracic nerve; the subclavius by the fifth and sixth cervical; serratus magnus by the posterior thoracic, upper division by the fifth cervical, middle by the sixth cervical (often fifth cervical also), lower by the sixth and seventh cervical.

Actions.—*Pectoralis major.*

Arm at side.	Arm abducted to 90 degrees.	Arm raised high.
First part of the muscle draws the arm up and in.	Draws the arm forward and rotates in.	Draws the arm forward to horizontal, and no farther.
Second part of the muscle draws the arm down and rotates in.	Draws the arm down, in, and rotates in.	Adducts, and draws down.

It assists the latissimus dorsi in adduction, opposes it in flexion; the lowest fibers are the best adductors; succeeding ones draw forward; used in swimming. Fixed above the pectorales, draw the body forward; the major does not draw up the ribs, the minor does not seem to, so that they have no inspiratory action.

The *subclavius* depresses the clavicle or steadies it; may act in inspiration; supports the sternoclavicular joint. The *pectoralis minor* draws the coracoid down and forward, depresses the shoulder, throws the lower angle of the scapula backward, acts with the levator and rhomboidei in rotating the scapula. The scapula is slung by the *serratus magnus* and rhomboidei, is kept in equilibrium by them; the lower portion of the serratus, combined with the trapezius, rotates the scapula on an axis near its superior angle and elevates the shoulder; the upper fibers bring the scapula forward and down, assisted by the pectoralis minor; the whole muscle brings the scapula forward, acts in all movements of pushing, keeps the scapula pressed to the ribs; of no importance in respiration; the middle fibers only might pull ribs down.

THE MUSCLES OF THE THORAX

Mm. intercostales externi, thicker behind than in front, **are directed** obliquely downward and forward between the external lips of the borders of two ribs; they **extend** from the tuberosities to the outer ends of the cartilages, not quite reaching them above, but continued along their borders in the lower two spaces. They are continued to the sternum as *anterior intercostal aponeuroses* or ligamenta intercostalia externa.

Mm. intercostales interni, thicker in front, incline down and back, but less obliquely than the external set; are **attached to** the ridge on the inner surfaces of the upper rib and to the internal lip of the upper border of the lower rib to which it is attached. Anteriorly they reach the sternum, and the last two are continuous with the internal oblique muscle; posteriorly they go to the angles or a little beyond. Their deficiency behind is supplied by the *posterior intercostal aponeuroses,* which merge on one side into the anterior costotransversalis ligament, and on the other into a thin fascia between the muscles.

Mm. infracostales (subcostales) consist of muscular and aponeurotic fibers, which are attached to the inner surface of one rib (usually the lower ribs), and **inserted** into the inner surface of the first, second, or third rib below. They are placed on the inner surface of the ribs, where the internal intercostal muscles cease.

M. Transversus Thoracis Anticus (triangularis sterni).—Muscular and tendinous fibers behind the costal cartilages **rise** from the ensiform, lower part of the sternum, and the cartilages of the lower two or three true ribs; the fibers pass up and out; the lowest are horizontal, the middle oblique, and the upper ones nearly vertical; **inserted** to the inner surfaces and lower borders of the sixth to the second costal cartilages, inclusive. It is a continuation upward of the transverse oblique muscle; it may be lacking on one side or both sides.

Gray includes the **diaphragm** under the muscles of the thorax (see page 194).

Nerves.—All by the intercostal nerve.

Actions.—The external intercostals elevate the rib below. The action of the internal intercostals is not definitely settled Haller early taught that they were accessory muscles of inspiration. Others that they are expiratory muscles. During operations for removal of the breast, when they can be seen under forced respiration, their actions seemed to be negative so far as accessory muscles of respiration were concerned. (Little.) Costal and diaphragmatic respiration are normally combined; the thorax is increased anteroposteriorly by a forward movement of the sternum, transversely by elevation and eversion of the ribs, vertically by the descent of diaphragm; extension of the vertebral column is also an agent. There are three views as to the action of the intercostals: Hamberger's, that the external elevate and the internal depress the ribs; Hutchinson's, that the external and anterior parts of the internal elevate, and the rest of the internal depress ribs; Haller's, that (1) the ribs are not joined as by a pivot to the vertebral column; (2) are not parallel bars, but curved arches; (3) no two ribs can move as they please, being connected above and below, but all move as a system; if fixed point be above, both the external and internal intercostals elevate the ribs and are inspiratory muscles; fixed below, they both depress and assist expiration.

MUSCLES AND FASCIÆ OF THE UPPER EXTREMITY

MUSCLES AND FASCIÆ OF THE SHOULDER AND ARM

The Acromial Region

The **deep fascia** is strong and tendinous over the back of the deltoid and infraspinatus; the infraspinatus fascia covers the teres minor and splits at the posterior border of the deltoid, a deep layer passing to the shoulder-joint under that muscle, a superficial layer to the spine of the scapula over the muscle.

M. Deltoideus.—**Origin**, in three portions; an anterior from the front of the outer third of the clavicle, a middle from the point and outer edge of the acromion, a posterior from the lower border of the scapular spine and triangular surface at its inner end, and from the infraspinatus fascia. These converge into the tendon of **insertion** into the deltoid tubercle of the humerus. The anterior and posterior parts run by long fasciculi into the marginal parts of the tendon; in the acromial portion most fibers rise in a bipenniform manner from the sides of four tendinous septa; the oblique fibers are inserted below into three septa which come up from the humerus to alternate with those above. Some fibers pass from the tip of the acromion to the tips of the lower septa, and some from the tips of the upper septa directly to the humerus.

The Posterior Scapular Region

1. *M. supraspinatus,* **from** inner part of the supraspinous fossa to region of the notch, from supraspinous fascia and transverse ligament; adherent to capsule and infraspinatus tendon; **inserted** into the upper of the three facets on the great tuberosity of the humerus.

2. *M. infraspinatus,* **rises** from the inner two-thirds of the infraspinous fossa, from the infraspinatus fascia, and under surface of the spine; fibers converge to a tendon concealed within the muscle and **inserted** into the middle facet of the great tuberosity. It may be inseparably connected with the teres minor.

3. *M. Teres Minor.*—**Origin,** from narrow grooved surface or dorsum of the scapula close to the axillary border, from septa between it, the teres major, and infraspinatus; **inserted** into the lowest facet on the great tuberosity and into the shaft for a short distance below.

May be a bursa under its insertion. It is behind the long head of the triceps and capsule; the dorsal scapular artery passes between it and bone.

4. *M. Teres Major.*—Is a thick somewhat flattened muscle. **Origin,** from the oval surface on the back part of the inferior angle of the scapula, and the fibrous septa common to it, and the teres minor and infraspinatus; **inserted,** by a flat tendon into the inner ridge of the bicipital groove of the humerus.

The Anterior Scapular Region

M. Subscapularis.—**Origin,** by muscular and tendinous fibers from the venter of the scapula and groove along the axillary border; **insertion,** small tuberosity of the humerus and into the shaft for a short distance. As in the deltoid, this muscle contains two sets of septa—one from the origin, and one from the insertion for attachment of the oblique muscular fibers. Some fibers from the axillary border of the muscle are usually inserted into the capsule, known as the *subscapularis minor.*

There is a bursa between the muscle and the capsule, and often another on its anterior surface (bursa coracobrachialis).

Nerves.—Supraspinatus and infraspinatus by the suprascapular nerve from the fifth and sixth cervical; others from the posterior cord of the brachial plexus, deltoid, and teres minor from the fifth and sixth cervical through the circumflex nerve; subscapularis by the fifth and sixth cervical through the upper and lower subscapular nerves.

Actions.—*Deltoid* abducts arm to 90 degrees, posterior fibers said to abduct only to 45 degrees; insertion of the trapezius corresponds to origin of the deltoid, so that the two are continuous in action; anterior part of the deltoid draws the humerus forward and rotates in; of both deltoids crosses the arms over the chest; posterior part draws the humerus backward and rotates out; supraspinatus, infraspinatus, and subscapularis steady the capsule while the deltoid acts. The *supraspinatus* only abducts. The *infraspinatus* rotates out and carries the arm back when it is raised. The *subscapularis* rotates in and carries the arm forward when it is raised. The *teres minor* rotates the raised humerus out and depresses it. All act as accessory ligaments to the joint. The teres major assists the latissimus dorsi in lowering the humerus, when raised, also acting as an internal rotator of the shoulder-joint.

THE MUSCLES AND FASCIÆ OF THE ARM

The **aponeurosis of the arm** (deep fascia) is thin over the biceps, strong over the triceps, and is attached to the humerus *intermuscular septa* (*ligamenta intermuscularia*). The *external intermuscular septum* extends from the outer epicondyle and supracondylar ridge to the deltoid insertion; it is pierced by the musculospiral nerve and superior profunda artery. The *internal intermuscular septum* extends from the inner epicondyle and inner supracondylar ridge to behind the coracobrachialis; it is pierced by the anastomotica magna artery.

The *internal brachial ligament* of Struthers is a fibrous band below the teres major insertion to the inner epicondyle; the ulnar nerve and inferior profunda artery pass between this band and the internal intermuscular septum.

The Muscles of the Anterior Humeral Region

M. Biceps Flexor Cubiti (brachii).—Its *short* or *inner head* **rises** with the coracobrachialis from the tip of the coracoid process; the *long head,* **from** the upper end of the glenoid cavity within the capsule by a tendon continuous on each side with the glenoid ligament; these two heads form a belly in the middle and lower part of the arm. The tendon of **insertion** is slightly twisted and attached to the back part of the tuberosity of the radius, separated from the forepart by a bursa. A second bursa may be between the tendon and ulna. From the inner side of the tendon a part branches off as an aponeurotic band or bicipital fascia, *p. n.,* and blends with the deep fascia of the forearm stretched across the brachial vessels and median nerve.

M. Coracobrachialis.—**Origin,** tip of the coracoid between the pectoralis minor and short head of the biceps, conjoined with the latter; **insertion,** inner border and inner surface of the humerus near its middle, between the triceps and the brachialis anticus; higher up some of its fibers are often inserted into a fibrous band arching over the latissimus dorsi and teres major tendons, and attached close to the small tuberosity. It is usually pierced by the musculocutaneous nerve.

Many varieties which seem to indicate it are formed of three parts, viz.: (1) A superior short part, from the coracoid to small tuberosity (*M. coracocapsularis*) to the capsule; (2) middle part, corresponding to the muscle usually seen; (3) inferior part, to the inner epicondyle or supracondylar process (*coracobrachialis minor*). The middle part is most constant in man, but is usually accompanied by a part of the third, with the musculocutaneous nerve between them. It may send a slip to the brachialis anticus or internal septum or internal brachial ligament.

M. brachialis anticus (brachialis internus, *p. n.*) **rises** from the lower half of the front of the humerus, nearly the whole of the internal intermuscular septum, and upper part of the external; it embraces the deltoid insertion by two processes, the outer of which is in the spiral groove as far as the upper limit of the deltoid tubercle. It is adherent to the capsule of the elbow-joint, and often sends a slip into it, and is **inserted** into the inner part of the rough surface at the junction of the coronoid process with the shaft of the ulna and to a part of the tubercle of the ulna.

The Muscles of the Posterior Humeral Region

M. extensor or *triceps extensor cubiti* occupies the whole posterior brachial region. Three heads are inserted into a common tendon occupying the posterior surface of the muscle from the middle of the arm to the elbow. The *middle* or *long head* (anconeus longus—*anconeus* was a term applied to any muscle attached to the olecranon) **rises** from the inferior glenoid tubercle of the scapula and adjacent portion of the axillary border; this forms the middle and superficial part of the muscle and ends on the inner margin of the tendon. The *external head* (anconeus brevis) **rises** above the spiral groove and from an aponeurotic arch of the external intermuscular septum as it crosses it, extending to the teres minor insertion above, and *inserted* into the upper end and outer border of the tendon. The *internal* or *deep head* (anconeus internus) **rises** from the whole posterior surface of the humerus below the spiral groove, from the lower part of the external intermuscular septum, from the whole of the internal, as high as the teres major; some of its fibers are **inserted** directly into the olecranon, but most join the deep surface of the tendon. The **common tendon is inserted** into the tuberosity of the olecranon, and externally a band is prolonged over the anconeus to the fascia of the forearm and posterior border of the ulna; it may send a slip to the capsule.

On removing the triceps a few muscular slips are sometimes found from the bone to the capsule, analogous to the subcrureus, and described by some as distinct from the triceps, called the *subanconeus.*

There is a bursa between the tendon and olecranon or in the tendon, sometimes one between the integument and tendon, rarely one between the tendon and ulnar nerve (retroepitrochlear).

Nerves.—Coracobrachialis and biceps by the musculocutaneous (fifth and sixth cervical), the brachialis anticus by the musculocutaneous, triceps by the musculospiral (seventh and eighth cervical).

Actions.—*Biceps* flexes the arm at the shoulder and the forearm at the elbow; after pronation of the forearm it is a powerful supinator and makes tense the fascia of the forearm; its inner head and *coracobrachialis* draw the arm in as well as up. The *brachialis anticus* is a simple flexor at the elbow. *Triceps,* internal and external heads are extensors at the elbow; the long head extends the arm on the scapula, keeps the head of the humerus in place, and assists in extending the forearm. These muscles may act from distal fixed points, as in climbing.

MUSCLES AND FASCIÆ OF THE FOREARM

The **superficial fascia** is most distinct at the elbow, contains the superficial veins, and below connects the skin with the palmar fascia.

The **aponeurosis** of the forearm (deep fascia) is composed largely of transverse fibers, strengthened by expansions from the condyles of the humerus, olecranon, and fascia over the biceps and triceps. The *anterior part* is weaker than the posterior, and continuous below into the anterior annular ligament (ligamentum carpi volare, *p. n.*); it sends in a thin layer between the superficial and deep muscles. The *posterior portion* sends off septa between the muscles and forms the posterior annular ligament (ligamentum carpi dorsale, *p. n.*). The tendon of the palmaris longus muscle is the only one passing in front of the anterior annular ligament.

The Anterior Radioulnar Region

Eight muscles, five superficial and three deep.

Superficial Layer.—All from a common tendon in the following order from without in:

1. *M. pronator teres* **rises** by two heads, the larger from the upper part of the inner condyle above the common tendon and from the common tendon and intermuscular septum; second head, thin and deep, from the inner margin of the coronoid process; **insertion,** by a flat tendon on the middle of the outer surface of the radius. The ulnar artery is beneath this muscle, and the median nerve between its heads.

2. *M. flexor carpi radialis* (M. radialis internus) **rises** from the common tendon and septa between it and the pronator teres, palmaris longus, and flexor sublimis; tendon begins below the middle of the forearm, passes through a special compartment of the anterior annular ligament through a groove in the trapezium; **inserted** into the base of the second metacarpal bone, anterior surface, and usually by a small slip to the base of the third.

3. *M. palmaris longus* is placed between the ulnar and radial flexors of the carpus, resting upon the flexor sublimis; **rises** from the common tendon, fascia, and septa, forming a short muscular belly ending in a slender tendon, **inserted** into the palmar fascia, and sends a slip to the abductor pollicis, sometimes one to the little finger muscle.

Most variable muscle of the body, lacking on both sides in one-third of the cases, on one side in one-half of the cases (Hallett). Muscular belly may occupy the middle of the tendon, lower end, both ends, or be absent; may be double or have additional origin from the coronoid or the radius. Inserted

Fig. 32

Superficial muscles of front of right forearm. (Testut.)

into the fascia of the forearm, flexor carpi ulnaris, pisiform, scaphoid, or little finger muscles. This muscle with the central part of the palmar fascia was a superficial flexor of the fingers, but has been reduced by the development of the other flexors.

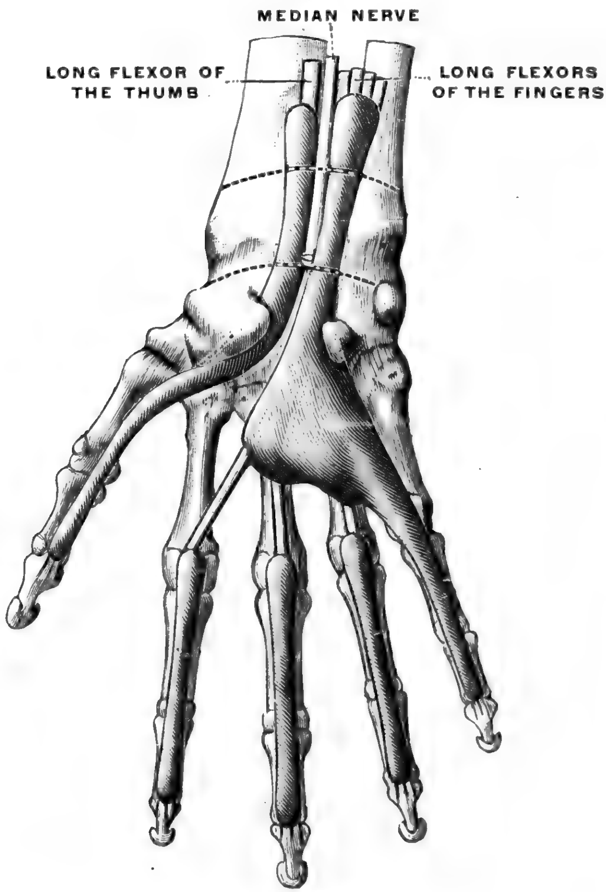
4. *M. flexor carpi ulnaris* (M. ulnaris internus) is the innermost of the superficial group; **rises** by two heads, one from the common tendon, and one from the inner side of the olecranon and upper two-thirds of the posterior border of the ulna by an aponeurosis common to it, the flexor profundus digitorum and the extensor carpi ulnaris; muscular fibers end in a tendon which occupies the anterior margin of the lower half of the muscle; posteriorly the muscular fibers continue down to within an inch of its insertion; **inserted** into the pisiform, by a small band to the anterior annular ligament, and prolonged by the pisometacarpal and pisouncinate ligaments to the fifth metacarpal and unciform.

The ulnar nerve and posterior ulnar recurrent artery pass between its two heads; the pisiform throws this tendon forward, so that the ulnar pulse connot be felt so well as the radial.

5. *M. flexor sublimis digitorum* (perforatus), placed behind the preceding, **rises** by three heads: (1) Inner condyle by the common tendon, fibrous septa, and internal lateral ligament; (2) internal margin of the coronoid; (3) anterior oblique line of the radius; divided below into four parts ending in tendons **inserted** into the mesial phalanges of the four inner digits. Through the annular ligament they are placed in pairs; the anterior pair are for the ring and middle fingers, the posterior for the index and little fingers. In the palm they diverge and enter a sheath with the flexor profundus; opposite the bases of the proximal phalanges the tendon divides and folds around the deep flexor, and is reunited behind it; the two portions again separate and pass on each side to the middle of the lateral border of the second phalanx.

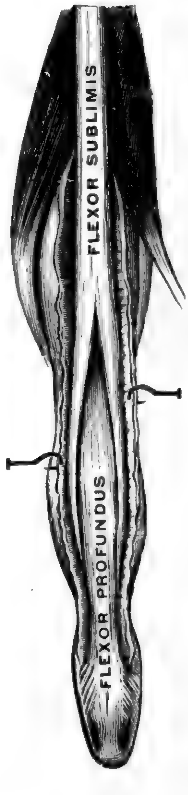
The Deep Muscles.—1. *M. flexor profundus digitorum* (perforans).—**Origin**, the upper three-fourths of the inner and anterior surface of the ulna, from not quite the ulnar half of the interosseous membrane for the same distance, and from an aponeurosis attached to the posterior border of the ulna, common to it, the flexor and extensor carpi ulnaris. Only one tendon (for the index finger) separates above the wrist; in the palm, as the tendons diverge, they give origin to the lumbricales; over the proximal and mesial phalanges the tendon is bound down by an osseoaponeurotic sheath, and opposite the proximal phalanx it passes through

Fig. 33



Synovial membranes of tendons in the palm, artificially distended. (Testut.)

Fig. 34



Tendon of flexor sublimis perforated by tendon of flexor profundus. (Testut.)

an opening in the flexor sublimis tendon, and is finally **inserted** by an expanded end into the base of the distal phalanx; over the middle and distal phalanx its tendon is marked by a longitudinal furrow or cleft.

The index finger portion is usually separate throughout, and comes mostly from the interosseous membrane; between the ring and little finger portions a considerable part of the inner surface of the ulna is free from muscular attachment.

The **sheaths of the flexor tendons** are opposite the proximal and middle phalanges, and formed of strong transverse bands, *ligamenta vaginalia;* opposite the joints the bands change into a thin membrane, strengthened by oblique decussating fibers, so that there are *annular* or *transverse* fibers, and *crucial* or *oblique.* The sheath has a synovial lining containing small folds, *vincula tendinum* or **ligamenta mucosa**, passing between the tendons and bones. There are two sets—*ligamenta brevia,* broad, four-sided, and membranous, passing between both the superficial and the deep tendons near their insertions and the lower part of the phalanx just above the joint capsule; the *ligamenta longa,* less constant, join the tendons at a higher level. Contained in the ligamentum breve of the deep flexor is a small band of yellow elastic tissue, *ligamentum subflavum,* passing from the tendon to the head of the second phalanx.

2. *M. flexor longus pollicis* **rises** from the anterior surface of the radius, below its oblique line to the edge of the pronator quadratus, and from the adjacent part of the interosseous membrane, and usually (27 out of 36 cases) receives a slip (fasciculus exilis) from the inner epicondyle or coronoid. The tendon passes between the sesamoid bones of the thumb and enters a canal similar to that of the other flexors, to be **inserted** into the base of the distal phalanx of the thumb. Its complete separation from the flexor profundus is characteristic of man.

3. *M. pronator quadratus,* just above the wrist, close to the bones behind the last two muscles, quadrilateral and flat, arises **from** the pronator ridge and inner part of the anterior surface of the ulna for the lower fourth, and from the inferior from the radiocarpal joint; **inserted** into the anterior surface and anterior margin of the shaft of the radius for a little less than its fourth.

Nerves.—Six and one-half of the above muscles by the median nerve, one and one-half by the ulnar. Pronator teres, flexor carpi radialis, palmaris longus, and condyloulnar head of the flexor sublimis receive median branches near the elbow; radial head of the flexor sublimis and belly for the index finger

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have separate twigs; the flexor longus pollicis, pronator quadratus, and outer half of the flexor profundus by the anterior interosseous branch of the median. Flexor carpi ulnaris and inner half of the flexor profundus by the ulnar.

The Radial Region

Three in number, from the lower third of the arm and upper third of the forearm in an almost continuous row.

1. *M. supinator longus* (brachioradialis) **rises** from the upper two-thirds of the external supracondylar ridge of the humerus and external intermuscular septum, limited above by the spiral groove; thin fleshy belly ends at the middle of the forearm in a flat tendon which expands at its **insertion** into the outer side of the radius at the base of the styloid process; its inner edge is united by fascia to the flexor carpi radialis; it sends some fibers to the aponeurosis on the back of the forearm.

2. *M. extensor carpi radialis longior* **rises** from the lower third of the external supracondylar ridge and external intermuscular septum and a few fibers from the common tendon; **inserted** into the radial half of the dorsal surface of the base of the second metacarpal.

3. *M. Extensor Carpi Radialis Brevior.*—**Origin,** by the common extensor tendon from the outer condyle, septa, external lateral ligament, fascia, and a fibrous arch over the radial nerve and radial recurrent vessels; **insertion,** into the radial half of the dorsal surface of the base of the metacarpal bone of the middle finger.

These tendons are crossed by the tendons of the first two thumb extensors a little above the wrist.

The Posterior Radioulnar Region

Two layers, muscles of the superficial layer inserted into the ulnar edge of the forearm and hand and into the fingers from the fifth to the second inclusive; of the deep layer into the radial edge of the forearm and hand and two outer fingers.

SUPERFICIAL LAYER.—1. *M. Extensor Communis Digitorum.*—**Origin** (from neither ulna nor radius), common extensor tendon from the external condyle of the humerus, orbicular ligament, fascia, and septa; there are three fleshy bellies, the innermost divided into two, four passing under the posterior annular ligament; the first and second pass to the index and middle fingers connected by a weak band, always transverse; the first is joined by the extensor indicis tendon at the metacarpophalangeal joint; the third runs to the ring finger and sends a slip to the middle finger tendon; the fourth divides, the outer larger part going to the ring finger, the inner part joining the outer division of the extensor minimi digiti tendon; this fourth is the smallest tendon, and receives muscular fibers as far as the wrist.

Opposite the metacarpophalangeal joints the tendons are bound down by transverse fibers from the front of the joint, ligamenta dorsalia; the tendon expands, is joined by a slip from the interossei, and on the radial side by the insertion of a lumbrical muscle, forming a broad aponeurosis, which divides at the lower part of the first phalanx into three slips—a central thin one for the base of the second, while the two lateral parts join and are **inserted** into the base of the last phalanx.

2. *M. extensor minimi digiti* (extensor digiti quinti proprius) **rises** from the superficial and deep fascia of the forearm, from the orbicular ligament, from the septa between it and common and ulnar extensors; its tendon is in a groove between the radius and ulna, and splits into two on the back of the hand, the outer being joined by a slip from the fourth common extensor tendon, and both parts **end on** the little finger, like the other extensor tendons.

3. *M. Extensor Carpi Ulnaris* (ulnaris externus).—**Origin,** common tendon, orbicular ligament, septa, fascia of the forearm, which is connected with the elbow-joint capsule, and anconeus; its belly in its middle third is bound to the posterior border of the ulna by aponeurosis, and may receive fibers from this fascia; **insertion,** tuberosity of the base of the fifth metacarpal. A bursa is under its tendon of origin in one-fourth of the cases.

In 52 per cent. of the cases a slip is continued anteriorly over the opponens minimi digiti to the fascia over that muscle, to the metacarpal bone or first phalanx of the little finger (analogue of the peroneus brevis of the little toe).

4. *M. anconeus* (quartus) fills the space between the triceps and extensor carpi ulnaris; is flat and triangular, covered by

fascia connected with the triceps; **rises** by a narrow tendon from a fossa on the inner and posterior part of the external condyle; upper fibers are transverse, the rest pass obliquely down and in **to** the radial aspect of the olecranon and adjacent upper third of the ulna. As a rule, its superior fibers are continuous with those of the internal head of the triceps. A bursa is found under its tendon of origin, not in children.

DEEP LAYER.—1. *M. Supinator Brevis.*—**Origin**, external lateral ligament, orbicular ligament, supinator ridge, oblique line of the ulna, and for a short distance on the outer border of the ulna, from the fascia covering it, which is connected with the external condyle; it regularly consists of two layers separated by the posterior interosseous nerve; the superficial one rises by aponeurotic fibers, the other by muscular. The fibers pass sling-like around the upper part of the radius to be inserted into a third of its length, limited by the anterior and posterior oblique lines, to its neck and elbow-joint capsule.

Anterior fibers may have insertion into the biceps tendon or tuberosity of the radius.

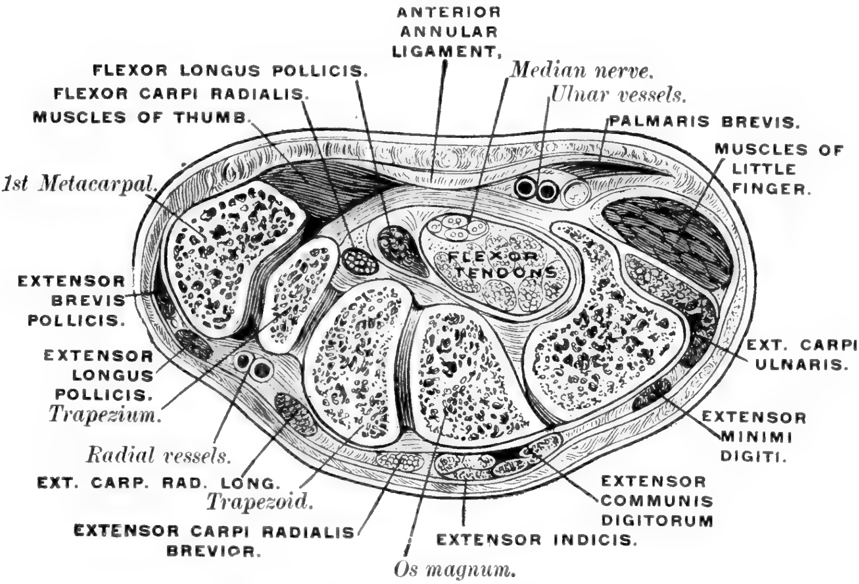
2. *M. Extensor Ossis Metacarpi Pollicis* (abducens pollicis longus).—**Origin**, upper part of the outer division of the posterior surface of the ulna below the supinator brevis, from the middle third of the posterior surface of the radius and interosseous membrane between. Its tendon passes over those of the radial extensors, and is **inserted** into the radial side of the base of the metacarpal bone of the thumb, and commonly by a slip into the trapezium, its tendon usually splitting.

3. *M. extensor longus pollicis* (extensor secundi internodii pollicis) **rises** below the extensor ossis on the middle third of the ulna and from the interosseous membrane for about 1 inch; its tendon passes over the radial extensors, and is **inserted** into the dorsal aspect of the base of the distal phalanx of the thumb. There is a tendency for it to divide into three parts, as in case of the extensor communis tendons, but all three converge to the base of the distal phalanx.

4. *M. Extensor Indicis Proprius* (M. indicator).—**Origin**, from the ulna below the extensor longus pollicis, and slightly from the interosseous membrane and fascia over the extensor carpi ulnaris; unites with the common extensor tendon for the index, and forms the usual **insertion**. This and the extensor

minimi digiti tendon are always on the ulnar side of the respective common extensor tendons.

Fig. 35



Transverse section through the carpus, showing the relative positions of the tendons, vessels, and nerves. (Henle.)

5. *M. Extensor Brevis Pollicis* (extensor primi internodii pollicis).—**Origin,** small part of the interosseous membrane and radius below the middle, next below the extensor ossis; **insertion,** proximal end of the proximal phalanx of the thumb on its dorsal aspect.

Nerves.—For the radial and posterior groups wholly by the musculospiral; the anconeus, supinator longus, and extensor carpi radialis longior by that nerve before it divides; all the others by its posterior interosseous branch.

Three nerves, therefore, supply all the muscles of the forearm—*median* and *ulnar* anteriorly (flexor carpi ulnaris and inner half of the flexor profundus by the ulnar), *musculospiral* externally and posteriorly.

THE MUSCLES AND FASCIÆ OF THE HANDS

Fascia of the dorsum is a thin layer prolonged from the posterior annular ligament and blending with the extensor expansions over the fingers; deeper than this the interossei are covered by thin aponeuroses.

Fascia of the palm (volar aponeurosis) consists of a strong central part and two lateral portions which cover the short muscles of the thumb and little finger. The central portion is the part commonly called the *palmar fascia;* it consists of fibers mostly prolonged from the palmaris longus, some from the annular ligament, thus forming two superficial layers with vertical fibers, between which is the palmaris brevis muscle; there is a deep layer of transverse fibers. Below, the fascia divides into four processes to join the digital sheaths; offsets are sent back to the deep transverse ligament at the heads of the metacarpals, forming a short canal above each finger for the flexors. Between the processes the transverse layer of fascia covers the lumbrical muscles, digital vessels, and nerves, passing over to the thumb and forefinger. At the clefts of the fingers a transverse band is called the *superficial transverse ligament,* or Gerdy's fibers. The interossei muscles also have a separate fascia continued below into the deep transverse ligament.

The Muscles of the Dorsal Surface

Extensor tendons already described.

Deep Muscles.—*Median Carpal Buræs.*—As the superficial and deep flexors and flexor longus pollicis enter the hollow of the hand they are bound into one tube lined by synovial tissue; a loose synovial sac is formed, passing up to the level of the radiocarpal joint and prolonged down the inner tendons to the digital sheath of the little finger, opening into it generally. The sheath for the tendon of the thumb is generally separated from the large sac by a sagittal septum behind the median nerve; the bursa extends but a short distance on the index and middle finger tendons.

The Radial Region

The following muscles constitute the *thenar eminence* and have a great variety of description. (See Quain and Henle.)

1. *M. Abductòr Pollicis* (brevis).—**Origin,** front of the annular ligament, ridge of the trapezium or tuberosity of the scaphoid; **insertion,** base of the proximal phalanx of the thumb, radial border, and sends a slip to the extensor tendons. (Henle calls this one belly, and what is described below as the outer head of the flexor brevis he calls the other belly of the abductor.)

2. *M. Flexor Brevis Pollicis.*—Outer or superficial head **rises** from the outer two-thirds of the annular ligament, **inserts** on the outer side of the base of the proximal phalanx, having a sesamoid bone developed in it; *inner* or *deep head* is very small, and between the adductor obliquus and outer head of the first dorsal interosseous; **rises** from the ulnar side of the first metacarpal; **inserted** into the inner side of the base of the proximal phalanx.

3. *M. adductor pollicis* Quain describes in two parts, separated by the radial artery as it enters the palm. The *adductor obliquus pollicis* (caput obliquum, *p. n.*), largest of the thumb muscles, **rises** from the upper ends of the second and third metacarpals, os magnum, anterior carpal ligaments, and sheath of the flexor carpi radialis; it passes on the inner side of the long flexor tendon to **insert** on the inner side of the base of the proximal phalanx, uniting with the adductor transversus and deep head of the flexor brevis. The inner sesamoid bone is developed in it. A considerable fasciculus passes behind the long flexor to join the superficial head of the flexor brevis and outer sesamoid bone. (This muscle is usually described as the inner head of the flexor brevis.)

4. The *adductor transversus pollicis* (caput transversum, *p. n.*) **rises** from the lower third of the front of the third metacarpal bone; **inserted** into the inner side of the base of the proximal phalanx of the thumb, and the common insertion sends a slip to the long extensor.

5. *M. opponens pollicis* beneath the abductor, **rises** from the annular ligament and outer side of the ridge of the trapezium; **inserted** by an upper layer into the whole length of the first metacarpal bone, radial border, and by its deeper layer into the head of the bone and radial part of its palmar surface.

The Ulnar Region

The following muscles constitute the *hypothenar eminence*.

1. *M. abductor minimi digiti* (abductor digiti quinti) **rises** from the lower border and inner surface of the pisiform, almost a continuation of the flexor carpi ulnaris; **insertion,** base of the proximal phalanx of the little finger, ulnar side, and into a sesamoid bone, sending a slip to the extensor tendon.

2. *M. flexor brevis minimi digiti* is separated from the abductor by deep branches of the ulnar nerve and artery, and **rises** from the annular ligament and tip of the unciform process; **inserted** into the base of the proximal phalanx by means of a tendinous arch passing over the flexors, attached to the radial and ulnar borders of the base. May be absent or fused with abductor.

3. *M. opponens minimi digiti* **rises** from the annular ligament and unciform process to **insert** on the whole length of the ulnar side of the fifth metacarpal and anterior surface of its head.

4. **Palmaris brevis** is a thin quadrilateral muscle placed beneath the integument on the ulnar side of the hand. It **arises** by tendinous fasciculi from the anterior annular ligament and palmar fascia; passing inward it is **inserted** into the skin on the inner border of the palm of the hand.

The Middle Palmar Region

The **dorsal interossei** are four in number, one for each space, not rising above the level of the bones, and numbered from without inward. Each rises from the two bones between which it is placed, most extensively from that supporting the finger upon which it acts. The tendon is inserted partly into the base of the proximal phalanx and partly into the extensor tendon. Each abducts its finger from the middle line; two are inserted into the middle finger, one on either side, one into the radial side of the index, and one into the ulnar side of the ring. The first dorsal interosseous is larger than the others, called the *abductor indicis;* its outer head comes from the proximal half of the ulnar border of the first metacarpal, its inner from the whole length of the radial border of the second metacarpal.

The **palmar interossei** are three in number, are adductors, and each rises from the lateral surface of the metacarpal of the finger on which it acts. They terminate like the dorsal tendons. The first belongs to the ulnar side of the index, the second and third to the radial sides of the ring and little fingers.

The lumbricales are four small muscles, not always wells defined. They **rise** from the tendons of the flexor profundus digitorum; the first and second, from the radial side and palmar surface of the tendons of the index and middle fingers respectively; 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 finger. They pass to the radial side of the corresponding fingers and opposite the metacarpophalangeal articulation; each tendon is inserted into the tendinous expansion of the extensor communis digitorum, covering the dorsal aspect of each finger.

Nerves of Hand Muscles.—Abductor pollicis, opponens pollicis, outer head of the flexor brevis pollicis, and outer two lumbricales are supplied by the median nerve. The palmaris brevis, muscles of the little finger, inner two lumbricales, all the interossei, adductores pollici, inner head of the flexor brevis pollicis, are supplied by the ulnar nerve.

Actions of Muscles of the Forearm and Hand.—*Pronation* by the pronator teres and quadratus and flexor carpi radialis slightly; pronator teres flexes the forearm; can only pronate when the radius is intact.

Supination by the supinator brevis, biceps, and supinator longus; the latter is a *flexor of the elbow* and brings the forearm into midsupination. *Radial extensors* of the wrist flex the elbow; others from the external condyle extend. *Flexion of the wrist* by the flexor carpi ulnaris and radialis, by the flexors of the fingers and palmaris longus.

Extension of the wrist by the extensor carpi ulnaris, the two radial extensors, and extensors of the fingers.

Abduction of the wrist by the radial flexor and radial extensors and extensors of the thumb.

Adduction of the wrist by the flexor and extensor carpi ulnares. The flexor carpi radialis and extensor carpi ulnaris act on the radiocarpal joint; the flexor carpi ulnaris and radial extensors on the midcarpal joint.

The extensors of the wrist are moderators of the long flexors of the fingers; the flexors of the wrist are moderators of the extensors of the fingers.

The dorsal interossei abduct the fingers from the middle one; the palmar adduct; the interossei and lumbricales flex the first phalanx and extend the last two.

Flexion in the Fingers.	Extension in the Fingers.
First phalanx, by the interossei and lumbricales.	By the extensor communis.
Second phalanx, by the flexor sublimis.	By the interossei and lumbricales.
Third phalanx, by the flexor profundus.	By the interossei and lumbricales.

When we flex the fingers they tend to approach, due to lateral ligaments and obliquity of the tendons.

The *palmaris longus* makes tense the palmar fascia, feebly flexes the forearm and wrist; all the muscles from the condyle feebly flex the forearm.

Palmaris brevis wrinkles the skin over the hypothenar eminence and protects the ulnar vessels and nerve from pressure when a foreign body is grasped.

Extension in the thumb is in the plane of abduction of the fingers, and its abduction is a movement forward. The action of its muscles and those of the little finger are indicated by their names; the flexors of the first phalanx in either case also extend the last, as the interossei would. The ulnar extensor and flexor of the carpus are moderators of the thumb extensors. There are three flexors of the wrist (including the palmaris longus) and three extensors, three flexors of the fingers and three extensors, three flexors of the thumb and three extensors.

THE MUSCLES AND FASCIÆ OF THE LOWER EXTREMITY

FASCIÆ OF THE THIGH

The **superficial fascia** is continuous with that of other parts of the body. Thick over gluteal region, passes over Poupart's ligament to the abdomen and inward above into the dartos of the scrotum and superficial fascia of the perineum. A deep layer of this fascia is continued across the saphenous opening, perforated by vessels and lymphatics, *cribriform fascia.*

The **deep fascia** or **fascia lata** is a strong membrane forming a continuous sheath around the limb; it is attached above to the back of the sacrum and coccyx in the median line, to the crest of the ilium, Poupart's ligament, body and rami of the pubis, ramus and tuberosity of the ischium, and lower margin of the great sacrosciatic ligament. It descends on the gluteus medius as far as the upper border of the gluteus maximus, which muscle it encases, and over the great trochanter a great part of the muscle is inserted between its layers. Fr m the forepart of the iliac crest to the outer tuberosity of the tibia is the *iliotibial band,* which receives the tensor vaginæ femoris and gluteus maximus insertions.

The fascia is thinnest at the inner part of the thigh over the abductors, and strengthened on each side of the patella by expansions from the vasti. Posteriorly it is continuous over the hamstrings and popliteal space.

On the front of the thigh, below the inner end of Poupart's ligament, is the *saphenous opening,* bounded externally by the *falciform border* (ligament of Burns), more distinctly curved above and below as the *superior* and *inferior cornua.* The inner extremity of the superior cornu passes to the inner side of the femoral sheath and to Gimbernat's ligament; it is the *femoral ligament* (Hey).

The parts external and internal to the saphenous opening are the *iliac* and *pubic portions*; the line is connected above with Poupart's ligament and the deep layer of superficial fascia (of Scarpa), and internally forms the falciform margin of the saphenous opening.

The pubic portion, or pectineal fascia, is attached above to the iliopectineal line, passes behind the femoral vessels, closely connected with the sheath, and merges into the iliac fascia and capsule of the hip.

The fascia lata has various deep processes; one is internal to the tensor vaginæ femoris on the surface of the vastus externus.

There are *external* and *internal intermuscular septa* inserted into the linea aspera.

The common femoral vessels are surrounded by the funnel-shaped *crural sheath,* made of transversalis fascia in front and iliac fascia behind; it is divided into three compartments—outermost for the artery, middle one for the vein, and innermost contains a lymphatic gland and fat, and when distended by a femoral hernia is the *crural canal,* $\frac{1}{2}$ to $1\frac{2}{5}$ inches (14 to 34 mm.) long. The *crural ring* (upper opening of the canal) is closed by the *septum crurale.*

THE ILIAC REGION

1. *M. Quadratus Lumborum.*—A quadrilateral muscle placed between the last rib and the pelvis. **Origin,** iliolumbar ligament, external lip of the crest of the ilium for 2 inches, from two, three, or four lumbar transverse processes by fleshy slips passing up anteriorly (Gray says this is a separate portion); **insertion,** inner half of last rib and upper four lumbar transverse processes.

Nerves.—Last dorsal and upper lumbar.

Actions.—Lateral flexor or both may extend the spine. Draws down the last rib, giving fixed point for the diaphragm, and aids inspiration (Quain); muscle of forced expiration (Henle). Fixed above, draws pelvis to one side, or both draw it forward.

2. *M. Iliopsoas.*—It has a broad outer head, iliacus, and a narrow inner head, psoas magnus.

Iliacus.—**Origin,** upper half of the iliac fossa down as far as the anterior inferior spine, posteriorly from ala of the sacroiliac and iliolumbar ligaments. **Inserted** mostly into tendon of the psoas; outermost fibers pass to the femur in front of and below the small trochanter.

Psoas Magnus (or Major).—**Origin,** by five fleshy slips from anterior surfaces and lower borders of the lumbar transverse process, and by a series of processes, each from a disk and contiguous margins of two bodies; the highest is attached to the last dorsal and first lumbar, and lowest to the fourth and fifth lumbar and intervertebral substance between them; fibers also come from the sacroiliac joint and sacrum. These attachments are connected with arches passing over the middle of the vertebræ. The fibers all unite to a thick, long muscle running along the brim of the pelvis, passing under Poupart's ligament, and **inserted** by a tendon into the small trochanter; separated by a bursa.

The common tendon is also separated from the capsule of the hip by a bursa.

3. *M. Psoas Parvus* (*or Minor*).—Placed on the surface of the psoas magnus; **rises** from the bodies of the last dorsal and first lumbar vertebræ and disk between; **ends** in a flat tendon merged into the iliac fascia and inserted into the ilio-pectineal line and eminence. When present its origin is variable; was absent on both sides in 40 per cent. of cases.

THE GLUTEAL REGION

M. Gluteus Maximus.—A quadrilateral, very coarse muscle. **Origin,** posterior fourth of the external lip of the iliac crest and rough surface between it and the posterior gluteal line, back of the last two pieces of the sacrum and first three of the coccyx, great sacrosciatic ligament, and aponeurosis of the erector spinæ.

The upper half and superficial fibers of the lower half are **inserted** into the fascia lata and continued into the iliotibial band; the deeper portion of the lower half into the gluteal ridge on the upper third of the shaft of the femur.

Between this and the great trochanter are a **multilocular bursa** and one or two small ones, another between it and the vastus externus; may be another between it and the tuber ischii.

M. Gluteus Medius.—**Origin,** ilium between the crest, the posterior, and middle curved lines, and from the fascia covering it, and from a band attached to the anterior posterior spine; fibers converge to an oblique impression going downward and forward to **insert** on the outer surface of the great trochanter; a small bursa between the bone and tendon. There may be a separate tendon to the upper part of the trochanter.

M. gluteus minimus is covered by the preceding, and **arises** from the whole surface on the ilium between the middle and inferior curved lines, and by a second head from the anterior superior spine; fibers converge into an aponeurotic tendon the outside of the muscle, **inserted** into an impression on the front of the great trochanter. Tendon is bound down by a band of capsule of the joint from the iliofemoral ligament; bursa between tendon and tubercle.

M. Pyriformis.—**Origin,** in pelvis by three digitations from the second, third, and fourth pieces of the sacrum, between and outside the anterior sacral foramina, from the hinder border of the ilium below the posterior inferior spine, and from the great sacrosciatic ligament. Emerges from the pelvis by the great sacrosciatic foramen; **inserted** into the upper border of the great trochanter.

May be divided by the external popliteal nerve (high division of the sciatic); inserted into a capsule or absent. May be a bursa under its insertion.

M. Obturator Internus.—**Origin,** deep surface of the obturator membrane, except below; from the fibrous arch, completing the canal for the obturator vessels and nerve; from the hip bone between the thyroid foramen and sacroiliac notch up to the iliopectineal line, and internally between the foramen and subpubic arch; from the obturator fascia. Emerges by the small sacrosciatic foramen, changes its direction, and passes around the trochlear surface of the ischium; **inserted** with the gemelli into the forepart of the inner surface of the great trochanter. It shows four or five tendinous bands on the surface turned toward the bone, which receive pinnate fibers. A layer of cartilage covers the grooves on the ischium and a large synovial bursa. Another may be between the capsule and tendon. Henle describes the *gemelli* (gemini) as parts of this muscle, calling them its outer head.

The *gemellus superior,* usually the smaller. **Origin,** outer and lower part of the ischial spine. *Gemellus inferior.*—**Origin,** upper part of the tuber ischii below the obturator internus; **inserted** with obturator internus into the great trochanter. They usually meet at origin beneath the obturator; they overlap it at the insertion. The superior gemellus may be absent or very small; inferior gemellus is more constant.

M. Quadratus Femoris.—**Origin,** outer border of the tuber ischii, and from the adjacent part of the external surface of the tuberosity; **insertion,** its fibers pass horizontally outward into the quadrate tubercle and back of the femur to the level of the small trochanter. Bursa between it and the small trochanter; it may be absent or replaced by the gemellus inferior.

M. Obturator Externus.—**Origin,** inner half of the superficial surface of the obturator membrane, body of the pubis, rami of the pubis and ischium; **passes out** in a groove between the acetabulum and tuber ischii, then up and backward, close to the lower and posterior surface of the neck of the femur to the bottom of the digital fossa. Sometimes bursa is between it and capsule.

Nerves.—Iliopsoas by the second and third lumbar; those for the iliacus are given off by the anterior crural; gluteus maximus by the inferior gluteal nerve; gluteus medius and minimus by the superior gluteal nerve; obturator internus gemelli, pyriformis, and quadratus femoris by the sacral plexus; obturator externus by the obturator nerve.

Actions of the glutei on the lower limb:

Flexion.	Extension.
Glut. med., anterior fibers. Glut. min., anterior fibers.	Glut. maximus. Glut. med., posterior fibers. Glut. min., posterior fibers.

Adduction.	Abduction.
Glut. med., anterior fibers (in sitting posture). Glut. min., anterior fibers (in sitting posture).	Glut., max., slight. Glut. med., Glut. min., } strong, whole muscle, especially mid-portion.

Rotate in.	Rotate out.
Glut. med., anterior fibers. Glut. min., anterior fibers.	Glut. max. Glut. med., posterior fibers. Glut. min., posterior fibers.

The *gluteus maximus* extends the trunk on the thigh as in ascending stairs; in walking it is not used, as the erect position is maintained by ligaments; steadies and supports the knee by the iliotibial band.

The *iliopsoas* flexes the thigh and rotates out; flexes the body on the thigh; the psoas bends the lumbar spine forward and laterally.

Psoas parvus makes tense the iliac fascia.

Pyriformis, obturator internus, and *gemelli* are external rotators after extension, abductors if the thigh is flexed.

Quadratus femoris is an external rotator, and may assist adduction.

Obturator externus is an external rotator; may flex and adduct.

THE THIGH MUSCLES

These are arranged in three sets—anterior, posterior, and internal—with superficial and deep layers, the former passing over two joints, the latter over one.

The Anterior Femoral Region

1. *M. tensor vaginæ femoris* (tensor fasciæ) lies in a groove between the gluteus medius, rectus, and sartorius. **Origin,** anterior part of the external lip of the iliac crest, notch between the two spines, fascia over the gluteus medius; **insertion,** between the two layers of the fascia lata 3 or 4 inches below the great trochanter, and from the insertion fibers are prolonged into the iliotibial band; the outer of the two laminæ covers the muscle; the deeper is connected with the origin of the rectus.

2. *M. Sartorius* (tailor muscle).—**Origin,** anterior superior spine of the ilium and small part of the notch immediately below; **insertion,** inner surface of the tibia near the tubercle, sending an expansion from the upper border to the capsule, one from the lower border to the fascia of the leg, and one to the tibia behind the tendons of the gracilis and semitendinosus. It is oblique at first, then vertical to the knee, and then curves forward.

M. Quadriceps Femoris, p. n.—Largest muscle of the body, four parts closely united. (*a*) *Rectus femoris,* in a straight line from the pelvis to the patella. **Origin,** by two heads; anterior one from the anterior inferior spine, and posterior from the impression just above the acetabulum; they join at an angle of 60 degrees close below the acetabulum; the tendon is anterior above, then in centre of the muscle. From this are pinnate fibers ending in an inferior tendon covering the lower two-thirds of the posterior surface of the belly, and leaving a median cleft in the muscle. The lower tendon becomes free 3 inches above the patella; is attached to the upper margin of that bone, and helps form the common tendon.

(*b*) The *vastus externus* (vastus lateralis, *p. n.*) is the outer part of the quadriceps. **Origin,** narrow and aponeurotic from the upper half of the anterior intertrochanteric line, outer part of the root of the great trochanter, outer side of the gluteal ridge, upper half of the outer lip of the linea aspera, from external intermuscular septum, and a strong aponeurosis extending over the upper two-thirds of the muscle. It rises in a succession of layers, the upper overlapping the lower. Aponeurosis of insertion occupies the deep surface of the muscle, joins the common tendon, and sends expansion to the lateral patellar ligaments and rectus tendon.

(*c* and *d*) *Vastus internus* (vastus medialis, *p. n.*) and *crureus* (femoralis, *p. n.*) seem to form one mass, but turn the rectus tendon well down, and above the patella is an interval which can be followed up between the two tendons on a line with the lower end of the anterior intertrochanteric line.

The *vastus internus* **rises** from a superficial aponeurosis and deeper fibers from the spiral line, inner lip of the linea aspera, and from tendons of the adductor longus and magnus; they end in a deep aponeurosis which enters the common tendon. Its muscular fibers pass lower than those of the externus, and are inserted into the inner margin of the patella, some into the rectus tendon.

Crureus, **rises** from upper two-thirds of the anterior surface of the femur, outer surface of the femur in front of and below the vastus externus, lower half of the external intermuscular septum; fibers end in a superficial aponeurosis which forms the deepest portion of the common tendon. They rise from a series of transverse arches with intervening bare spaces on the front of the femur. Between the crureus and the vastus internus most of the internal surface of the bone is free.

The *common* or *suprapatellar tendon* is **inserted** into the forepart of the upper border of the patella, and a few fibers are prolonged over its anterior surface into the ligamentum patellæ.

M. subcrureus (articularis genu, *p. n.*) is the name of a few fibers which may be regarded as the deepest layer of the crureus. **Origin,** anterior surface of the femur in the lower fourth; **insertion,** separated by a fat layer from the vasti into the synovial membrane of the knee-joint.

These muscles may be bilaminar.

Hunter's canal is a three-cornered passage in the middle two-fourths of the thigh, in the angle between the adductors magnus and longus and vastus internus. It is made a canal by a bridge of fascia, and contains the femoral artery, vein, and internal saphenous nerve.

Nerves.—Anterior crural for the quadriceps and sartorius; superior gluteal for the tensor vaginæ femoris.

Actions.—*Sartorius* flexes the hip and knee with eversion of the thigh; rotates the leg inward.

Quadriceps femoris extends the leg; not necessary for the maintenance of the erect attitude.

Rectus femoris also flexes the hip; its posterior head is tense when the thigh is bent. Lower fibers of the vastus internus draw the patella in.

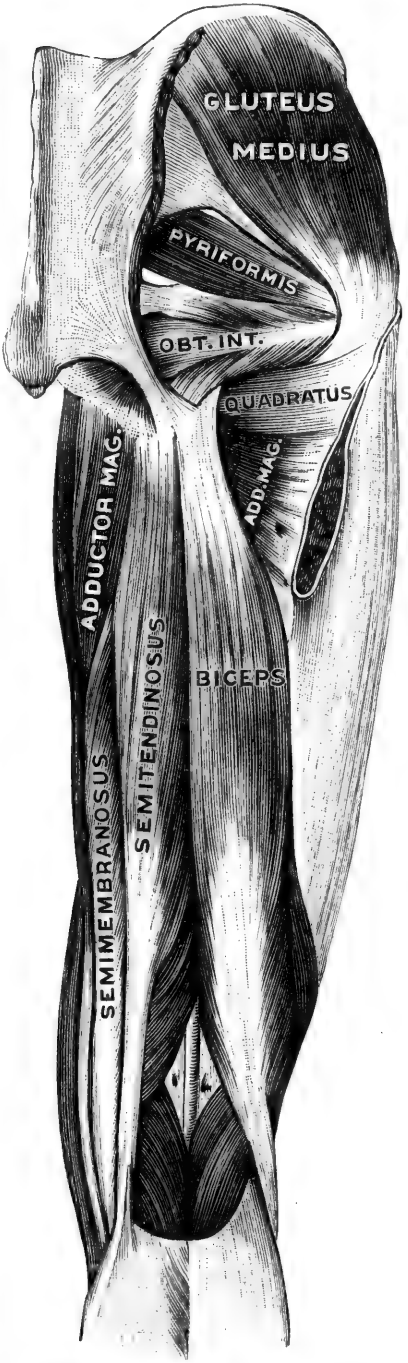
Tensor vaginæ femoris rotates in and abducts, assisted by the gluteus maximus; counteracts the gluteus maximus, which tends to draw the iliotibial band backward.

The Posterior Femoral Region (Hamstrings)

1. *M. Biceps Femoris.*—**Origin,** *long head* by a tendon common to it and semitendinosus from inner impression on the lower part of the ischial tuberosity, and from the sacrosciatic ligament; *short* head from the middle third of the outer lip of the linea aspera and external intermuscular septum; fibers from both heads end in a tendon **inserted** into the upper and outer part of the head of the fibula by two portions embracing the external lateral ligament; some fibers pass forward and inward to the external tuberosity of the tibia and to the fascia of the leg.

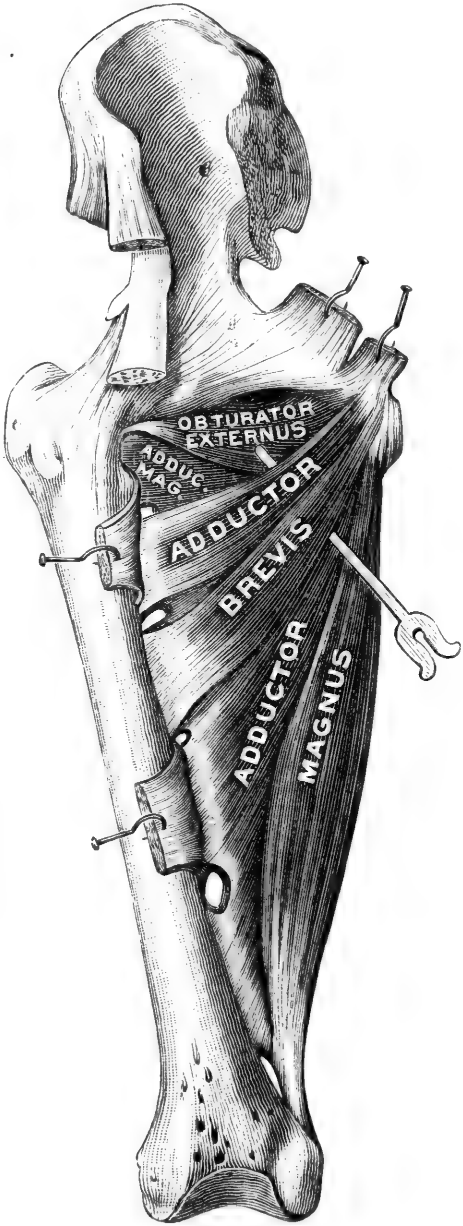
2. *M. Semitendinosus.*—**Rises** from the tuberosity of the ischium and tendon common to it and biceps for 3 inches. Terminates in the lower third of the thigh in a long, slender tendon, and curves forward in an expanded form to **insert** on the upper part of the inner surface of the tibia or anterior

Fig. 36



Muscles in the dorsum of the right thigh. (Testut.)

Fig. 37



Adductores magnus and brevis of the right side. (Testut.)

crest of the tibia, and sends a process to the fascia of the leg. It is below the gracilis tendon, covered by the sartorius, and a bursa separates the three from the internal lateral ligament. It has a thin, oblique intersection in the middle of its belly.

3. *M. Semimembranosus.*—**Origin,** tuber ischii above and outside the tendon of the biceps and semitendinosus, and its tendon is grooved posteriorly for the common tendon of those two muscles. Tendon of origin is on the outer side of the muscle for three-fourths the length of the thigh; tendon of **insertion,** on the opposite side of the muscle, and turns forward and is inserted by four parts (1) into horizontal groove on the back of the inner tuberosity of the tibia; (2) expansion is sent up and in as the posterior oblique ligament of the knee-joint; (3) down to the fascia over the popliteus muscle; (4) to form the short internal lateral ligament of the knee-joint.

The hamstring muscles descend mostly in contact with each other and are bound down by the fascia lata; inferiorly they diverge the biceps to the outer side, semimembranosus and semitendinosus to the inner side, forming the upper borders of the popliteal space, the inferior margins of which are formed by the heads of the gastrocnemius.

Varieties.—Great reduction in size of the semimembranosus or absence.

Nerves.—Great sciatic, from its internal popliteal division, except that to the short head of the biceps, which is from the external popliteal division.

Actions.—Flex the knee, and then can rotate the tibia and drag it back under the femur; biceps outward, other two inward. Powerful extensors of the hip, and limit flexion of that joint when knee is extended.

The Internal Femoral Region

1. *M. Pectineus.*—**Origin,** iliopectineal line from the iliopectineal eminence and spine of the pubis, and slightly from bone in front of this, and from the fascia over the muscle; **insertion,** femur behind the small trochanter and upper part of the line passing from this trochanter to the linea aspera. At origin surfaces are frontal, at insertion are sagittal.

2. *M. Adductor Longus* (adductor femoris longus).—Flat and triangular, internal to the pectineus, on same plane.

Origin, short tendon from the body of the pubis below the crest and near the angle; **insertion,** inner lip of the linea aspera, united to the vastus internus in front and adductor magnus behind.

3. *M. Gracilis,* or adductor gracilis.—**Origin,** inner margin of pubic bone and whole length of its inferior ramus, thin and flat, then narrow and thicker. A round tendon in the lower third of the thigh, curving forward below, **inserted** into the inner side of the tibia just above the semitendinosus, and covered by the sartorius.

M. Adductor Brevis.—**Origin,** body and inferior ramus of the pubis below the adductor longus, between the gracilis and obturator externus; **insertion,** into the whole line from the small trochanter to the linea aspera behind the pectineus. It lies between the adductor magnus and longus.

1. *M. Adductor Femoris Minimus.*—This is what is described with the adductor magnus, usually as its anterior and superior portion. **Origin,** body of the pubis and ischiopubic rami; **insertion,** femur, in a line from the quadratus femoris to the upper end of the linea aspera, and a short distance along it.

2. *M. Adductor Magnus.*—**Origin,** ischial ramus internal to the above muscle and outer half of the triangular space on the posteroinferior surface of the tuber ischii; fibers pass in two layers, one to the inner lip of the linea aspera, and the line extending from the great trochanter to the linea aspera, and the other on the inner side of the opening for the femoral vessels by a distinct rounded tendon to **insert** on the adductor tubercle on the inner condyle of the femur. The femoral attachment is interrupted by three or four tendinous arches for the perforating arteries.

Adductor longus may extend to knee, inseparable from the adductor magnus.

Adductor brevis may consist of two or three parts.

Adductor magnus, condylar part may be distinct; usual in apes.

Nerves.—Adductors by the obturator nerve, but adductor magnus also by the great sciatic; pectineus regularly by a branch from the anterior crural, an offset from the obturator and accessory obturator nerve, only occasionally present.

Actions.—All adduct the thigh. *Pectineus, adductor longus* and *brevis* flex the hip, while part of *adductor magnus* from the ischial tuberosity to the condyle may extend the thigh and rotate in. *Gracilis* flexes the knee and rotates the leg inward. Adductors and opponens, the gluteals, balance the body in walking.

(1) Anterior fibers of the gluteal medius (2) and minimus; (3) tensor vaginæ femoris; and some say (4) the condylar part of the adductor magnus, rotate the thigh inward.

THE MUSCLES AND FASCIÆ OF THE LEG

There are three groups, as in the forearm; the extensors are on the anterior side and the flexors on the posterior. The number of muscles passing over two joints is less in the leg; no muscle on the anterior and fibular side springs from a point above the knee.

Fasciæ.—The *aponeurosis* of the leg is not continued over the subcutaneous surface of the bones, but immediately blends with the periosteum. It is dense at the upper and front part. Posteriorly it is continuous with fascia lata, and receives accessions from the biceps, sartorius, gracilis, and semitendinosus and membranosus tendons. Over the popliteal space are transverse fibers. It gives off intermuscular septa. In front of and on the sides of the ankle the aponeurosis is strengthened by strong bands, forming the annular ligaments.

The *anterior annular ligament* is composed of an upper and a lower band. The upper band, *ligamentum annulare, p. n.*, is transverse between the anterior borders of the fibula and tibia. The tibialis anticus tendon alone has a synovial sheath under it. The lower band, *ligamentum cruciatum, p. n.*, resembles the letter Y placed on its side, one arm being external and two internal. The outer portion springs from the hollow of the os calcis, forming a strong loop, "*fundiform ligament of Retzius,*" surrounding the peroneus tertius and extensor longus digitorum. The horizontal and most constant internal band passes to the internal malleolus over the extensor proprius hallucis; and practically beneath the tibialis anticus tendon; the lower band (oblique) crosses both these tendons, and becomes continuous with the plantar fascia on the inner side of the sole.

There are three synovial sheaths in all—a common one for the peroneus tertius and extensor longus, one for the extensor proprius hallucis, and one for the tibialis anticus; may be a bursa between the fundiform ligament and neck of the astragalus.

Internal annular ligament (*ligamentum laciniatum, p. n.*) covers the flexor tendons, completing canals; it is attached to the inner malleolus and posteriorly to the inner side of the os calcis.

The *external annular ligament* (*retinaculum peronæorum superius, p. n.*) forms sheaths for the long and short peroneal tendons, passing from the outer malleolus to the os calcis. May be subcutaneous bursæ over the malleoli and over the lower end of the tendo Achillis.

The Anterior Tibiofibular Region (Extensors)

1. *M. Tibialis Anticus* ("chain-muscle").—**Origin,** external tuberosity of the tibia, upper half of the outer surface of that bone, and adjacent interosseous membrane, fascia of the leg, and intermuscular septum; **insertion,** oval mark on the inner and lower part of the internal cuneiform and first metatarsal, dividing into two slips. A small bursa may be under its near insertion.

A part may be inserted into the astragalus, also a slip may go to the head of the first metatarsal or base of first phalanx.

2. *M. Extensor Longus* or *Proprius Hallucis.*—**Origin,** middle two-fourths of the narrow anterior surface of the fibula and contiguous portion of the interosseous membrane; **insertion,** base of the terminal phalanx of the great toe on the dorsal aspect. It spreads in an expansion on each side over the metatarsophalangeal articulation, and almost always sends a slip to the base of the proximal phalanx.

3. *M. Extensor Longus Digitorum Pedis.*—**Origin,** external tuberosity of the tibia, head and upper two-thirds of the anterior surface of the fibula, very largely from the septa and fascia and interosseous membrane above the origin of the extensor proprius hallucis. Tendon divides into four slips for the outer four toes. They are continued into expansions which are joined on the proximal phalanx by processes from the interossei and lumbricales. They divide into three parts—the middle **inserted** into the middle phalanx; the lateral parts

unite, and are inserted into the base of the terminal phalanx, as in the case of the extensors of the fingers.

Tendons to the second and fifth toes may be doubled; extra slips from one or more tendons to the metatarsal bones, to short extensor, or to interossei; a slip to the great toe. Slip for the little toe may be separable to origin.

4. *M. Peroneus Tertius.*—**Origin** (below the extensor longus digitorum, and united with it), lower third or more of the anterior surface of the fibula, from the interosseous membrane, from the septum between it and the peroneus brevis; **insertion,** upper surface of the base of the fifth metatarsal, sometimes the fourth. This muscle is peculiar to man.

Nerves.—All by the anterior tibial nerve.

The Fibular or Peroneal Region

1. *M. Peroneus Longus.*—**Origin,** few fibers from the outer tuberosity of the tibia, head and upper two-thirds of the external surface of the fibula, fascia of the leg, and septa on each side. It has an anterior and a posterior head with peroneal nerve between. Tendon begins in the lower half of the leg, passes behind the external malleolus; then forward on the outer side of the os calcis, winds around the tuberosity of the cuboid, and enters its groove, crosses the sole obliquely, and is **inserted** into the outer side of the tuberosity of the first metatarsal, and slightly into the internal cuneiform; a frequent offset to the base of the second metatarsal and first dorsal interosseous.

Both peroneal tendons are in the same sheath under the annular ligament, but on the os calcis each has its own sheath, separated by the peroneal spine, when it exists, and a fibrous septum. A single synovial sac sends two processes down into the special sheaths.

A second synovial membrane is in the cuboid groove. A sesamoid fibrocartilage or bone is on the tendon, playing over the cuboid tuberosity. The special fascia binding down the peroneal tendons is the *retinaculum peronæorum inferius, p. n.*

2. *M. Peroneus Brevis.*—It lies deeper than the peroneus longus. **Origin,** lower two-thirds of the external surface of the fibula from the septa and a flat tendon on the surface turned toward the bone; **insertion,** tuberosity at the base of

the fifth metatarsal, sending a small slip to the outer edge of the extensor of the little toe or forepart of the metatarsal bone.

Nerves.—Musculocutaneous branch of the external popliteal or peroneal nerve.

The Posterior Tibiofibular Region (Flexors)

Superficial Muscles.—1. *Mm. Gastrocnemius* and *Soleus* (m. triceps suræ).—Gastrocnemius has two large heads from the femur, **terminating** at the middle of the leg in a common tendon. *Outer* head **from** the depression on the outer side of the external condyle above the tuberosity, and from the posterior surface of the femur just above that condyle. *Inner* head **from** the upper part of the internal condyle behind the adductor tubercle, and lower end of the supracondylar ridge. The two heads enlarge, and soon meet, do not join, separated superficially by a groove and deeply by a thin band.

The inferior tendon is broad and aponeurotic, and on the deep surface.

The lower edge of each muscular part is convex downward; the inner head is the broader and thicker, and descends the lower in its insertion into the common tendon. A bursa is between it and the semimembranosus, and another between it and the femur.

Outer head may develop a sesamoid fibrocartilage or bone over the condyle of the femur.

Soleus.—**Origin,** externally from the posterior surface of the head and upper third of the shaft of the fibula; internally, oblique line and inner border of the tibia to its middle, and from a tendinous arch over the popliteal vessels and nerve; fibers rise to a large extent from two tendinous laminæ which descend in the muscle, one from the fibula and one from the tibia. Fibers from the anterior surfaces of these laminæ converge to a median septum; fibers from their posterior surfaces pass down and back to an aponeurosis covering the back surface of the muscle. The **tendon of insertion** is prolonged from this aponeurosis, joined by the median septum. Muscular fibers are continued down on the deep surface of the tendo Achillis near to the heel. The tibial head is almost peculiar to man.

Tendo Achillis, broad at first, contracts to within $1\frac{1}{2}$ inches of the heel, then expands, and is inserted into the middle and lower parts of the posterior surface of the tuberosity of the os calcis, a bursa having all the characters of a synovial membrane, with vascular and fatty synovial tufts, separating it from the upper part of this surface.

2. *M. Plantaris.*—**Origin,** femur above the external condyle and from the posterior ligament of the knee-joint. Muscular belly 3 to 4 inches long, and the long, slender tendon turns in between the gastrocnemius and soleus to the inner border of the tendo Achillis, and **inserted** by its side into the calcaneum

May join tendo Achillis, end in fascia of the leg or internal annular ligament, or be enclosed in the tendo Achillis. Absent in 7.5 per cent. It is the remains of a superficial flexor of the digits, like the palmaris longus.

3. *M. Popliteus.*—**Origin,** round tendon, 1 inch long, from the groove on the outer surface of the external condyle of the femur, within the capsule of the joint, in contact with the semilunar cartilage, and by muscular fibers from the ligamentum popliteus arcuatum. Fibers pass down and are **inserted** into the triangular surface of the tibia above the oblique line, and into the aponeurosis over the muscle. The tendon is in the groove on the femur only in full flexion. Henle gives origin below and insertion above.

The Deep Muscles (Flexors)

1. *M. Flexor Longus Digitorum Pedis* (Perforans).—**Origin,** inner portion of the posterior surface of the tibia for the middle two-fourths of its length, from the aponeurosis over the tibialis posticus. Descends behind the internal malleolus, passes forward and obliquely outward, having crossed the tibialis posticus tendon in the leg, and now crossing that of the flexor longus hallucis, in each case superficially. It divides into four parts **for** terminal phalanges of the four lesser toes. The whole arrangement of the vincula accessoria, etc., is as for the fingers.

2. *M. Tibialis Posticus,* beneath the two long flexors. **Origin,** posterior surface of the interosseous membrane, outer part of the posterior surface of the tibia below the oblique line to the middle of the bone, whole inner surface of the fibula, and from the aponeurosis over it. Tendon along the inner

border of the muscle, free at the level of the lower tibiofibular articulation, passes behind the inner malleolus; **inserted** into the tuberosity of the scaphoid, with offsets to the three cuneiform, to cuboid, to bases of the second, third, and fourth metatarsals, and to the transverse tarsal ligament and flexor longus hallucis tendon, and sends a thin process back to the sustentaculum tali.

3. *M. Flexor Longus Hallucis.*—**Origin,** lower two-thirds of the posterior surface of the fibula, septum between it and the peronei; aponeurosis common to it and flexor longus digitorum. Tendon at the posterior surface of the muscle traverses groove on the back of the astragalus and under surface of the sustentaculum, gives slip to the flexor longus digitorum in the sole of the foot, and proceeds to the base of the terminal phalanx of the great toe.

Nearly always a slip from the flexor hallucis to the flexor digitorum, and (1 in 5) another from the flexor digitorum to the flexor hallucis.

Slip from the flexor hallucis passes to the second and third toes, 52 per cent.; to the second only, 28 per cent.; to the second, third, and fourth, 19 per cent.; or rarely to all four.

Nerves.—Gastrocnemius, plantaris, and popliteus by the internal popliteal nerve. Soleus by the internal popliteal and posterior tibial. Flexor longus digitorum, flexor longus hallucis, and tibialis posticus by the posterior tibial nerve.

MUSCLES AND FASCIÆ OF THE FOOT

Fascia of the dorsum is a thin layer over the extensor tendons, with deeper layers over the short extensors and interossei.

Superficial fascia of the sole forms a thick cushion of fatty lobules bound down by bands passing vertically from the skin to deep fascia. Small bursæ over the heel and first and fifth metacarpals.

Deep Fascia of the Sole.—*Plantar fascia,* central and two lateral portions. The *inner* is thin and loose, covers the abductor hallucis, and is continuous with the dorsal fascia and internal annular ligament. *Outer* part covers the abductor minimi digiti, and forms a thick band, especially between the outer tubercle of the os calcis and tuberosity of the fifth metatarsal, continuous with the dorsal fascia, and sends a prolongation forward over the short flexors of the little toe.

Central portion has dense white, glistening fibers, from the inner tubercle of the os calcis to the roots of the toes; divides into five processes in front. Thin transverse fibers cover the lumbricals and digital nerves. Identical arrangement as in the palmar fascia; fibers to the digital sheaths, superficial transverse ligament, and skin, and deep processes to the transverse metatarsal ligament.

Two *intermuscular septa* are between the middle and lateral portions, giving partial origin to muscles.

Superficial transverse ligament of the toes is in folds of skin at the interdigital clefts, connected to the tendon sheath beneath. Connects all five digits.

The Dorsal Region

1. *M. Extensor Brevis Digitorum Pedis.*—**Rises** from forepart and upper and outer surface of the os calcis, in front of the groove for the peroneus brevis tendon, and from the anterior ligament of the ankle. The tendon has several vertical leaflets from which muscular fibers rise, dividing into three bellies which unite with the outer border of the long extensors for the second, third, and fourth toes.

2. *M. Extensor Brevis Hallucis* (often described with the above).—**Origin**, two heads—outer from the upper surface of the os calcis close by the anterior edge, and connected with the extensor brevis digitorum; inner head from the lower arm of the annular ligament. Tendon is free at the tarsometatarsal joint, passes under the tendon of the extensor longus hallucis, and is expanded and inserts on the dorsum of the proximal phalanx.

The Plantar Region

None corresponding to the palmaris brevis; three groups as in the hand, middle group richer than that of the hand. Great toe, fewer than the thumb group. Little toe group, like number and arrangement.

The Central Group.—1. *M. Flexor Brevis Digitorum* (perforatus).—**Origin,** inner tubercle of the os calcis, plantar fascia, septa, and calcaneocuboid ligaments. **Terminates** in four slender tendons inserted into the sides of the mesial phalanges of the four outer toes; each divides and gives passage to the long flexor, as does the flexor sublimis of the hand.

2. *Flexor Accessorius* (m. quadratus plantæ, *p. n.*).—Henle calls it the "plantar head of the flexor longus digitorum." Flat quadrilateral muscle. **Origin,** two heads—internal and larger from the inner surface of the os calcis; external, narrow and tendinous, from the under surface of the os calcis just in front of the outer tuberosity and from the long plantar ligament; **insertion,** external border and upper surface of the flexor longus digitorum tendon.

3. *Mm. Lumbricales.*—Four in number. **Origin,** at points of division of the flexor longus digitorum tendon, each attached to two tendons, except the most internal one; they pass to the inner side of the four outer toes; **inserted** into the bases of the proximal phalanges (Henle).

The Internal Group.—1. *M. Abductor Hallucis.*—**Origin,** inner tubercle of the os calcis, internal annular ligament, septum, plantar fascia; **insertion,** inner border of the base of the proximal phalanx of the great toe, inner sesamoid bone, and tendon of the extensor longus hallucis. Slip to the proximal phalanx of the second toe. May have a second head from the scaphoid.

2. *M. Flexor Brevis Hallucis.*—**Origin,** flat process from the cuboid inner border, from the slip of the tibialis posticus tendon to the two outer cuneiform bones, from the sheath of the flexor longus digitorum; **inserted** by two heads into the inner and outer borders of the base of the proximal phalanx, in connection with the abductor hallucis and adductors. Sesamoid bone in each head.

Origin from the os calcis or long plantar ligament. Sends slip to the second toe, first phalanx. Inner head regarded by some as belonging to the abductor.

3. *M. adductor hallucis* has two heads, as in hand, an oblique and transverse, only more separated.

Caput Obliquum, p. n.—**Origin,** tarsal extremities of the third and fourth metatarsals, sheath of the peroneus longus, calcaneocuboid ligament, and third cuneiform; **insertion,** outer side of the base of the first phalanx of the great toe, somewhat above the tendon of the peroneus longus.

Caput transversum (*transversus pedis*) is covered by flexor tendons. **Origin,** inferior tarsometatarsal ligaments of the three outer toes and transverse metatarsal ligaments; **inserted** with the oblique head and flexor brevis into the first phalanx of the great toe and extensor tendon.

The External Group.—1. *M. Abductor Minimi Digiti.*—**Origin,** both tubercles of the os calcis, external septum, band of the plantar fascia between the external tubercle and base of the fifth metatarsal; **inserted** into the base of the fifth metatarsal and outer side of the base of the first phalanx of the little toe. The tendon usually receives muscle fibers from the base of the fifth metatarsal.

2. *M. Flexor Brevis Minimi Digiti.*—**Origin,** base of the fifth metatarsal, and calcaneocuboid ligament, sheath of the peroneus longus; **insertion,** base and external border of the first phalanx of the little toe; deeper fibers generally end on the anterior half of the fifth metatarsal.

The Interossei Muscles

Mm. interossei, as in the hand, are seven in number, four dorsal and three plantar. The dorsal project downward as low as the plantar, and alternate with them.

Each **dorsal interosseous** has two heads and a central tendon, which is inserted partly into the base of the proximal phalanx and into the aponeurosis of the corresponding slip of the common extensor tendon. The first two are inserted, one on either side of the second toe, the third and fourth into the outer sides of the third and fourth. Inner head of the first is small, and rises from the first metatarsal and internal cuneiform; the third and fourth receive fibers from the sheath of the peroneus longus.

Plantar interossei, rise from the inner and under surface of the third, fourth, and fifth metatarsals, one-headed, and from the sheath of the peroneus longus. Inserted into the inner side of the proximal phalanges of the third, fourth, and fifth toes, and into the aponeurosis of the corresponding slip of the common extensor tendon.

Nerves.—Extensor brevis by the anterior tibial. Flexor brevis digitorum, abductor and flexor brevis hallucis, and innermost lumbricalis by the internal plantar; all the others by the external plantar.

Actions.—*Popliteus* flexes the knee and rotates the leg in, pulls on the capsule of the joint, and keeps the popliteal bursa open. The dorsum of the foot and anterior surface of the leg is the *extensor surface;* the opposite side is the *flexor surface,* so that raising the foot on the front of the leg is really extension, and depressing it is flexion; it is customary to apply reverse terms to these acts.

Gastrocnemius flexes the knee, extends the ankle, combines with the soleus and lifts the heel or raises the body on toes.

Tibialis anticus and *peroneus tertius* flex the ankle; the former rotates in, adducts, raises the first metatarsal bone.

Tibialis posticus, peroneus longus and *brevis* are extensors. Tibialis posticus and flexors of the toes rotate the foot in. The three peronei and extensors of the toes rotate out.

Peroneus longus strengthens the transverse arch, lifts the outer border of the foot in walking, extends the foot, depresses the first metatarsal, abducts the forefoot, rotates out.

Flexors and extensors of the toes, interossei, and lumbricales act as do the corresponding muscles of the hand.

Flexor accessorius modifies the action of the flexor longus digitorum, as those tendons cannot enter the foot in a straight line.

The *extensor brevis digitorum* does the same for the extensor communis, though here they are not so much needed, and their function is not so evident.

Extensors of the foot slightly rotate in; flexors of the foot slightly rotate out; *plantaris* indirectly pulls up the capsule of the ankle-joint and slightly aids the gastrocnemius.

Flexors of the Foot.	Extensors of the Foot.
Tibialis anticus.	Tendo Achillis.
Extensor communis digitorum.	Peroneus longus and brevis.
Extensor proprius hallucis.	Tibialis posticus.
Peroneus tertius.	Flexor longus digitorum and hallucis.

Adduction.	Abduction.
Tibialis posticus (strongly).	Peroneus brevis.
Tendo Achillis (weakly).	Peroneus longus.
Perhaps tendons behind the inner malleolus, perhaps the tibialis anticus.	

Rotation in.	Rotation out.
Tibialis anticus (strongly).	Peroneus longus.
Tendo Achillis.	Extensor communis digitorum.
	Peroneus tertius.

NOTE.—The following are included under Muscles of Thorax, page 198.

Levatores costarum muscles are twelve in number, one on each side. They **arise** by small tendinous and fleshy bundles from the extremities of the transverse processes of the seventh cervical and the eleven upper thoracic vertebræ. Pass obliquely downward and outward to be **inserted** into the upper border, between the tubercle and the angle, of the rib, adjacent to its vertebræ of origin, below. Each of the inferior levatores divides into two fasciculi, one of which is inserted as above described; the other fasciculus passes to the second rib below its origin; thus each of the lower ribs receives fibers from two vertebræ.

QUESTIONS ON THE MUSCLES AND FASCIÆ

THE MUSCLES AND FASCIÆ OF THE NECK

What structure lies on the Scalenus anticus?
Give the nerve supply of the Sternomastoid.
What muscles form the boundaries of the triangles of the neck?

THE MUSCLES AND FASCIÆ OF THE TRUNK

From what vertebræ does the Latissimus dorsi arise?
Give the nerve supply of the Trapezius.
What muscles form the boundaries of the suboccipital triangle?
Describe the arrangement of the aponeuroses of the Internal abdominal oblique and Transversalis with reference to the Rectus abdominalis.
What forms Poupart's ligament? Gimbernat's ligament?
Describe the inguinal canal.
Where do the fibres of the clavicular portion of the Pectoralis major insert?
Where do the fibres of the lowest part of the Pectoralis major insert?
What is the relation of the Pectoralis major tendon to the biceps?

THE MUSCLES AND FASCIÆ OF THE UPPER EXTREMITY

Take each muscle of the upper extremity, state its shape and location, and minutely its origin, its insertion, the direction of its fibres, its innervation, and its relation to important structures.
What structure passes through the Coracobrachialis?
What connection is there between the glenoid head of the Biceps and the glenoid ligament?
Which of the Teres muscles is behind the tendon of the scapular head of the Triceps?
What nerve supplies the Teres minor?
What limits the Supinator longus above?
What separates the origins of the internal and external heads of the Triceps?
What passes between the heads of the Pronator radii teres?
From how many bones does the Flexor sublimis digitorum arise?
From how many bones does the Flexor profundus digitorum arise?
What structures pass between the heads of the Flexor carpi ulnaris?
What passes between the planes of the Supinator brevis?
Which tendons are the more superficial where they cross, those of the short extensors of the thumb or those of the Extensores carpi radialis longior and brevior?
What arises just below the Extensor longus pollicis?
To which side of the common extensor tendon to the index finger is the tendon of the Extensor indicis?
Has the Extensor minimi digiti one or two tendons?

Beginning with the Supinator longus in the upper third of the forearm, name in order the muscles found in passing completely around the forearm.

What is the nerve supply of the Flexor digitorum profundis?

What is the nerve supply of the Flexor brevis pollicis?

THE MUSCLES AND FASCIÆ OF THE LOWER EXTREMITY

Take each muscle separately, state its shape and location, and give precisely its origin, insertion, direction of fibres, innervation, and relation to important structures.

What is the nerve supply of the Pectineus, the Tensor vaginæ femoris, and Adductor magnus?

What is the relation of the Obdurator externus to the neck of the femur?

What angle does the part of the Obturator internus within the pelvis make with the part without the pelvis?

What relation does the Semimembranosus bear to the Biceps and Semitendinosus just below the tuber ischii?

Draw the linea aspera with its upper and lower extensions, marking the muscular attachments.

What is the order of the deep layer of the posterior leg muscles from within outward, and what is the relation of their tendons behind the internal malleolus?

Which of the Peronei muscles is superficial, then posterior, and then inferior to the corresponding portion of the other?

Describe the femoral canal.

PART IV

THE VASCULAR SYSTEMS

THE PERICARDIUM

THE pericardium is a fibroserous membrane which invests the heart and the great vessels at their origin for about two inches. Below, it is attached to the diaphragm and its central tendon; in front it is separated from the sternum by the thymic remains, some areolar tissue, and overlapped by the margins of the lungs, especially, of the left; behind it are the esophagus, bronchi, and descending aorta; laterally it is covered by the pleuræ, with the phrenic nerve and vessels running between the two membranes.

The pericardium consists of a fibrous and a serous layer. The fibrous layer is attached below to the diaphragm and its central tendon. Above, it forms a tubular investment for the great vessels which is lost on the external coat, and may be traced above into the pretracheal portion of the deep cervical fascia, and in front is attached to the posterior surface of the sternum by the superior and inferior **sternopericardial ligaments** (Luschka). The vessels invested are the aorta, superior vena cava, both pulmonary arteries, and all the pulmonary veins.

The serous layer invests the heart and is reflected to the fibrous layer. It also invests the great vessels for about two inches. The aorta and pulmonary artery are completely invested, thus between them and the auricles posteriorly is the transverse pericardial sinus. The pulmonary veins and both the venæ cavæ are only partially invested.

THE HEART

The heart is a hollow muscular organ, of somewhat conical form, lying between the lungs and enclosed by the pericardium, It contains four chambers, an auricle and a ventricle on each side.

It lies obliquely, the base being directed upward, backward, and toward the right, and extending from the level of the fifth to that of the eighth dorsal vertebra, and the apex looking downward, forward, and to the left, its impulse against the chest wall being felt in the fifth left interspace, about $3\frac{1}{4}$ inches from the middle of the sternum. The heart lies more in the left than in the right side of the chest, its base being held in position by the great vessels which are connected with it; its posterior or posteroinferior surface is flat, formed chiefly by the left ventricle, and rests on the diaphragm; and its anterior surface, formed chiefly by the right ventricle, but also partly by the left, is convex and covered to some extent by the lungs. Of the borders, the right is long and thin, and the left is shorter and thick. The length of the heart is about 5 inches; its greatest breadth is $3\frac{1}{2}$ inches; its thickness is about $2\frac{1}{2}$ inches. Its weight is 10 to 12 ounces in the male, 8 to 10 in the female, and it increases with age.

Externally it presents a deep transverse groove, the auriculo-ventricular, which marks off an upper or auricular and a lower or ventricular portion; this latter part presents a longitudinal furrow on the front and back, the former being somewhat to the left, the latter to the right, marking off the right and left ventricles.

The interior of the heart is divided by a longitudinal septum into a right and a left part, and these, in turn, are divided into an auricle and a ventricle.

THE RIGHT AURICLE

The right auricle is larger than the left, its wall being about one line in thickness and its capacity 2 ounces. Its cavity is divided into two parts, the sinus venosus and the appendix auriculæ, the former lying between the entrances of the two venæ cavæ, the latter overlapping the commencement of the aorta. Within the auricle the following parts present themselves for examination:

1. The *orifice of the superior vena cava,* looking downward and forward.

2. The *orifice of the inferior vena cava,* at the lowest part, near the septum, looking upward and inward.

3. Between the two caval openings a projection, the *tuberculum Loweri.*

4. The *opening of the coronary sinus,* between the inferior cava and the auriculoventricular opening, and protected by the fold of endocardium forming the coronary valve.

5. Numerous small openings (*foramina Thebesii*) of the venæ cordis minimæ.

6. The *auriculoventricular opening.*

7. The *Eustachian valve,* between the front of the inferior vena cava and the auriculoventricular orifice. It is semilunar in form, the free concave margin sending one cornu to join the front of the annulus ovalis and the other to the auricular wall.

8. The *fossa ovalis,* at the back of the septum, in the situation of the fetal foramen ovale, its prominent margin being known as the annulus ovalis.

9. The *musculi pectinati,* small elevated columns which transverse the appendix and the adjacent part of the sinus.

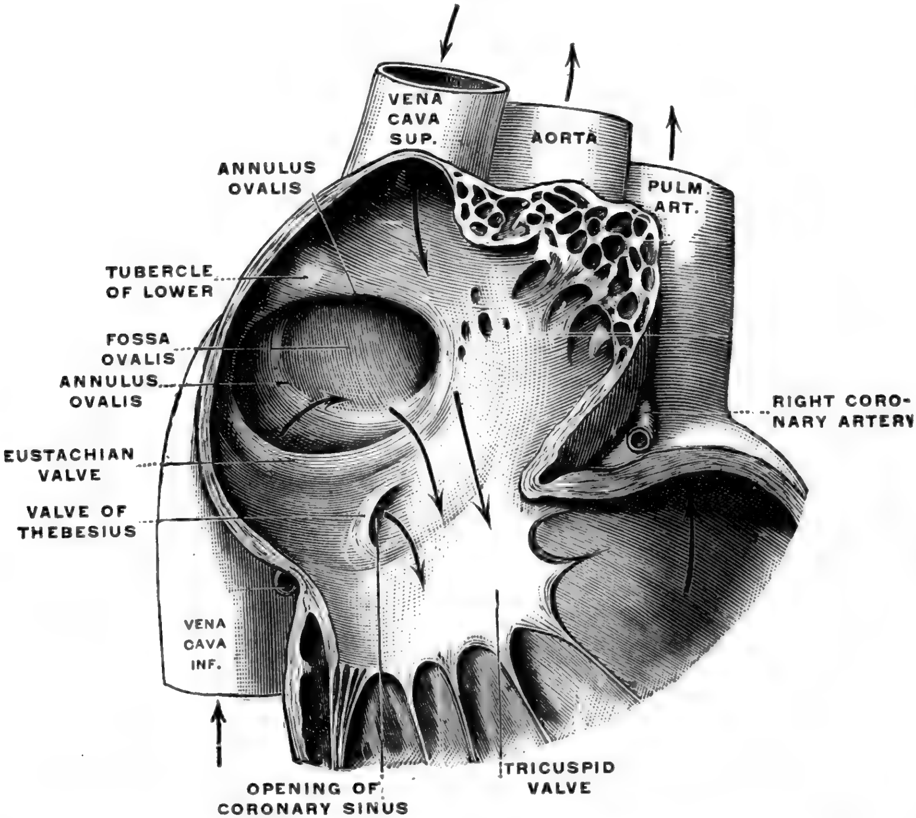
The auriculoventricular bundle of His is situated in the median septum between the auricles and ventricles. It commences near the opening of the coronary sinus, where the fibers converge, forming a node (node of Tawara), and continues as a compact bundle which passes forward in the lower part of the pars membranacea septi to the upper part of the muscle portion of the ventricular septum, and divides into right and left fasciculi. Each limb passes to the papillary muscles surrounded by a layer of connective tissue, embedded within the muscle of the septum, but in the lower parts of the ventricles each fasciculus divides into several strands, which pass to the papillary muscles and entire internal surface of the ventricular surfaces and forms there histological connections with the cells of the heart muscle fibers (Gray).

THE RIGHT VENTRICLE

The right ventricle is pyramidal, and extends nearly to the apex of the heart. It is bounded internally by the convex surface of the septum ventriculorum, and prolonged above and internally into a pouch, the infundibulum, or conus arteriosus, from which springs the pulmonary artery. Its cavity has a capacity of three ounces. On opening the ventricle the following parts are presented for examination:

1. The *auriculoventricular orifice*, oval in form and placed near the right side of the heart. Around its circumference is a fibrous ring, and it is guarded by the tricuspid valve.

Fig. 38



Right auricle and part of right ventricle, the front wall having been removed. (Testut.)

2. The *opening of the pulmonary artery*, circular in form, at the summit of the conus arteriosus, near the septum; is guarded by the pulmonary valve (semilunar).

3. The *tricuspid valve* consists of three triangular flaps formed of fibrous tissue covered by endocardium. They are continuous

with one another at their bases, and their free margins and ventricular surfaces give attachment to the chordæ tendineæ. Their central part is thick and strong, the lateral margins thinner and flexible.

4. The *chordæ tendineæ* are attached as follows: several to the attached margin of each flap, blending with the fibrous ring; several to the strong central part; and the finest and most numerous to the margins of each curtain.

5. The *columnæ carneæ* are projecting bundles of muscular substance found all over the ventricular wall excepting the conus arteriosus. They are of three classes: the first are mere ridges, attached by one side and both extremities; the second are attached only by both extremities; the third (musculi papillares) are two in number, an anterior and a posterior, attached by only one extremity, the free end having chordæ tendineæ attached to it.

6. The three *semilunar valves* guard the pulmonary orifice. They are semicircular, their free margins being thick and tendinous and presenting at the middle a small fibrous nodule, the corpus Arantii. On each side of this body, just behind the free margin, the valve presents a small thinned-out interval, and when the valves are closed during diastole these valves (*lunulæ*) are in contact, and so also are the three nodules. These latter prevent any leakage from the triangular space which would otherwise be left.

7. At the commencement of the pulmonary artery are three pouches, the *sinuses of Valsalva,* placed one behind each valve. They resemble those of the aorta, but are smaller.

THE LEFT AURICLE

The left auricle is smaller and thicker walled than the right, and consists, like the right, of a sinus and an appendix. The latter overlaps the pulmonary artery. Within it presents the following features of interest:

The *orifices of the pulmonary veins,* opening two into the right and two into the left side; the *auriculoventricular orifice;* and a few musculi pectinati on the inner side of the appendix.

THE LEFT VENTRICLE

The left ventricle is longer than the right, and forms the apex of the heart. Its walls are three times as thick as those of the right. Within it presents for examination:

1. The *auriculoventricular orifice,* which is smaller than the right and guarded by the mitral or bicuspid valve; and the aortic opening, in front and to the right of the preceding, guarded by the semilunar valves.
2. The *mitral valve* is attached, like the tricuspid, on the right side. It consists of two curtains which are larger and thicker than those of the tricuspid, and of two smaller segments, one at each angle of junction of the former. They are furnished with chordæ tendineæ.
3. The *aortic semilunar valves* are similar to but larger and stronger than the pulmonary valves.
4. *Columnæ carneæ* are found as in the right ventricle, and the musculi papillares are very large; one is attached to the anterior wall, the other to the posterior.

The Endocardium.—The inner surface of the heart is lined by a thin membrane, the endocardium, continuous with the inner lining of the great bloodvessels, and helping to form by its folds the various valves.

Blood and Nerve Supply.—The heart is supplied with blood by the coronary arteries, and with nerves by the cardiac plexuses, formed by branches of the pneumogastric and sympathetic nerves.

The **muscle fibers** of the heart are **attached to** cartilaginous rings which surround the auriculoventricular and arterial orifices.

THE ARTERIES

There are two great arterial systems—(1) the pulmonary, (2) the corporeal.

THE PULMONARY ARTERIAL SYSTEM

The **pulmonary artery** is a short, wide vessel, 2 inches in length. Commencing at the base of the right ventricle, it curves upward and backward, to end under the transverse aorta by dividing into a right and a left branch.

Relations.—*In front,* second left intercostal space and cartilage, left border of the sternum; *behind,* origin of the aorta, left auricle; *above,* transverse aorta, remains of the ductus arteriosus; *to the right,* right appendix and coronary artery, ascending aorta; *to the left,* left appendix and coronary artery.

This vessel, with the ascending aorta, is enclosed in a sheath of pericardium. It winds around the aorta, being at first in front, and later to the left side, of the ascending portion. In fetal life the ductus arteriosus connects it a little to the left of its bifurcation with the transverse aorta.

Each branch enters the root of the corresponding lung; the right, the larger, passing behind the ascending aorta and superior vena cava; the left, in front of the descending aorta. The left divides into two branches for the lobes of the left lung; the right also divides into two primary branches for the upper and lower lobes. From the lower one of these is sent a branch to the middle lobe.

THE CORPOREAL ARTERIAL SYSTEM

The Aorta

The aorta is the main trunk from which spring the systemic arteries. From the base of the left ventricle it runs upward, forward, and to the right as far as the second right cartilage; then backward and to the left, over the root of the left lung, to the fourth dorsal vertebra; thence, along the spine, it descends through the thorax and abdomen, to divide, at the fourth lumbar, into the common iliacs.

It has been divided, for convenience of description, into the arch and the descending aorta. The arch is subdivided into the ascending, transverse, and descending parts; the descending aorta, into the thoracic and abdominal portions.

The Arch of the Aorta

The **ascending part of the arch** runs upward, forward, and to the right, from a point opposite the lower border of the third left cartilage, to the upper border of the second right cartilage. Close to its origin it presents three small dilatations, the sinuses of Valsalva, indicating the situation of the semilunar valves.

Relations.—*In front,* pulmonary artery, right appendix, thoracic fascia, right pleura, pericardium, remains of the thymus gland; *behind,* root of the right lung, including right pulmonary vessels, left auricle; *to the right,* right auricle, superior vena cava; *to the left,* pulmonary artery.

The **transverse part of the arch** passes backward and to the left as far as the left side of the body of the fourth dorsal vertebra.

Relations.—*In front,* lungs and pleura, thymic remains, left vagus, phrenic and superficial cardiac nerves, left superior intercostal vein; *behind,* trachea, esophagus, thoracic duct, deep cardiac plexus, left recurrent nerve; *above,* left innominate vein and the branches of this portion of the aorta, viz., innominate, left carotid, and subclavian arteries; *below,* left bronchus, bifurcation of the pulmonary artery, ductus arteriosus, left recurrent nerve.

The **descending part of the arch** descends to the lower border of the fifth dorsal vertebra, ending in the thoracic aorta.

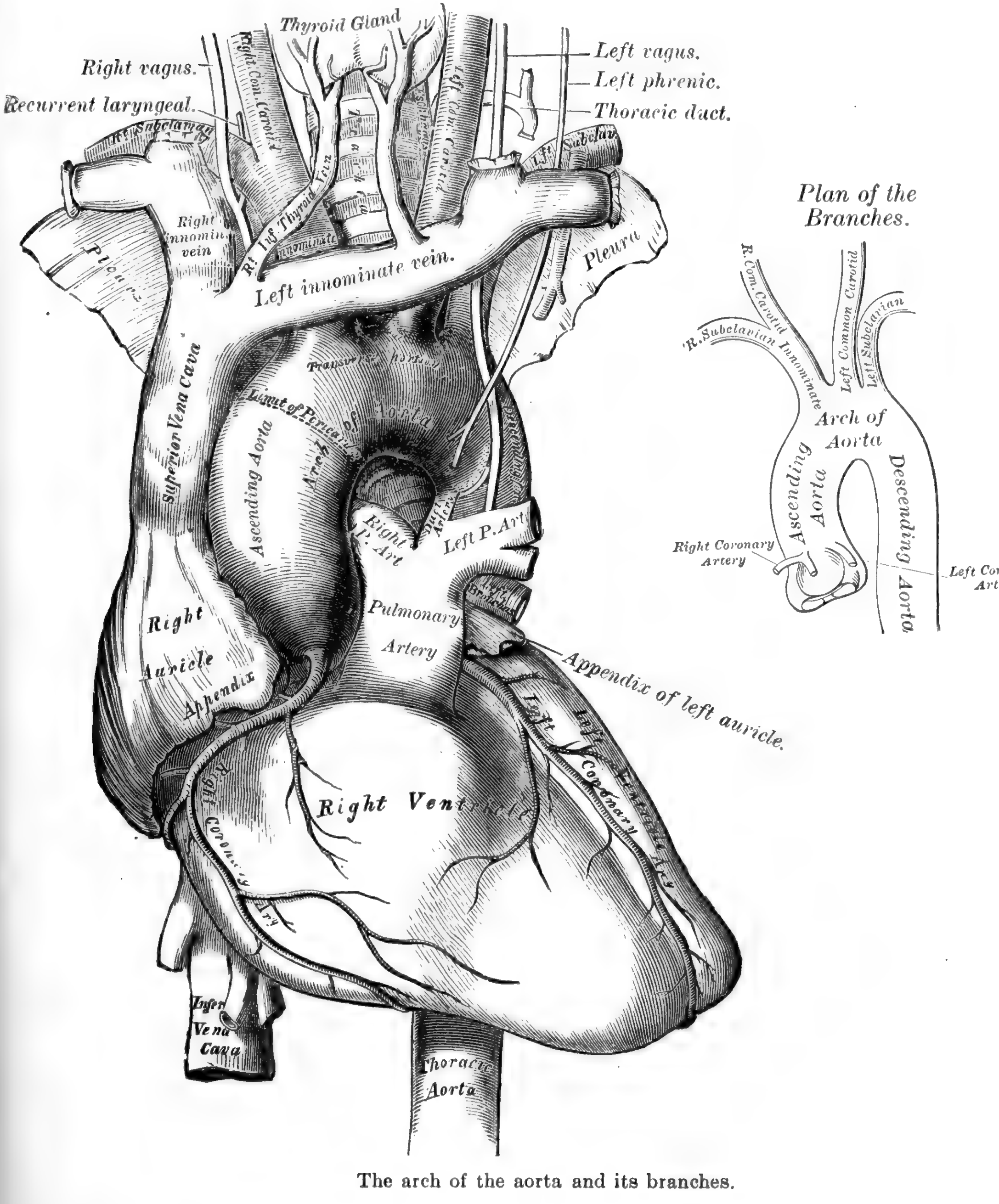
Relations.—*In front,* root of the left lung covered by pleura; *behind,* left side of the body of the fifth dorsal vertebra; *right side,* esophagus, thoracic duct; *left side,* left lung, covered by pleura.

The Branches of the Arch of the Aorta

The **branches of the arch** are five—coronary, right and left, from the ascending part; and the innominate, left carotid, and left subclavian, from the transverse part. The descending part gives off no branches.

The **coronary arteries** supply the heart and the coats of the great vessels. They emerge on either side of the pulmonary artery, between it and the corresponding appendix auriculæ. Each arises from a sinus of Valsalva, just above the free margin of the corresponding semilunar valve, and is distributed to the muscular substance of the heart, its valves and septa, running along the grooves on its surfaces, and anastomosing freely with the other, and, by means of twigs to the aorta and pulmonary artery, with the pericardiac and bronchial vessels. Each

Fig. 39

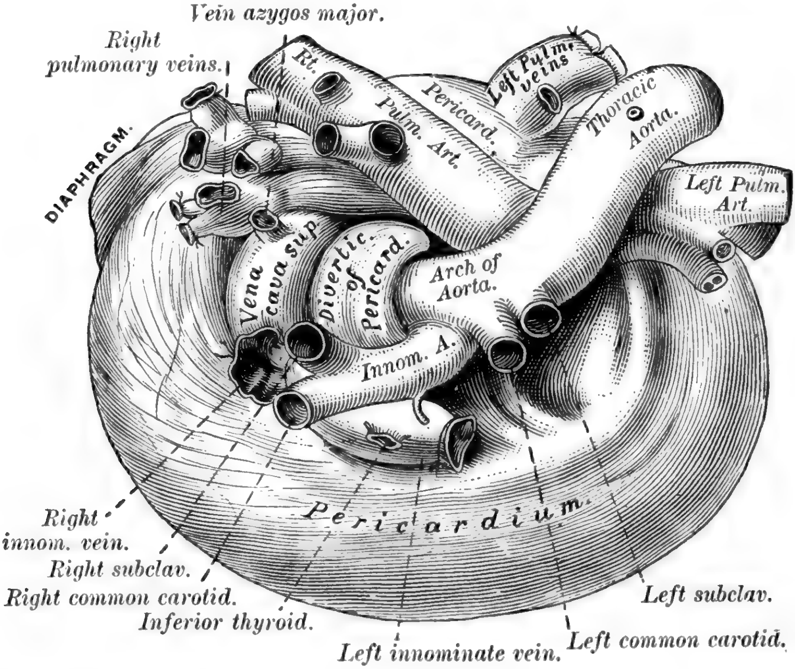


The arch of the aorta and its branches.

divides into two primary branches, the right vessel running in the posterior and the left in the anterior, interventricular, and auriculoventricular grooves.

The **innominate (brachiocephalic) artery** is the largest branch. It arises in front of the left carotid, and runs obliquely to the right sternoclavicular joint, where it divides into the right common carotid and right subclavian.

Fig. 40



Relation of great vessels at base of heart, seen from above. (From a preparation in the Museum of the Royal College of Surgeons of England.)

Relations.—*In front,* manubrium sterni, sternohyoid and thyroid muscles, thymic remains, left innominate and right inferior thyroid veins, inferior cervical cardiac nerve from the right vagus; *behind,* trachea and pleura; *right side,* pleura, right vagus, right phrenic nerve, and the right innominate vein; *left side,* remains of the thymus and trachea. The left carotid artery as it leaves the arch is *behind* and to *the left* of this vessel. The innominate regularly gives off no branches. Occasionally, however, a thymic or bronchial branch or the arteria thyroidea ima arises from it.

The **common carotid arteries** are identical in course, branches, and relations in the neck, but differ in their origin. Thus, the right is a branch of bifurcation of the innominate, while the left is a primary branch of the transverse aorta. From its origin the left carotid passes obliquely upward and outward to the left sternoclavicular joint, and from that point follows a course corresponding to that of the right carotid. A *thoracic portion* of the left carotid artery is therefore described.

Relations.—*In front,* sternum, sternohyoid and thyroid, thymic remains, left innominate vein; *behind,* trachea, esophagus, thoracic duct; *left side,* left subclavian artery, left vagus; *right side,* inferior thyroid veins and innominate artery, which is also somewhat in front.

In the neck each carotid ascends from the sternoclavicular joint to the level of the upper border of the thyroid cartilage, there dividing into the external and internal carotids. Each is enclosed, with the internal jugular vein and vagus, in a sheath of deep cervical fascia, the several structures being partitioned from one another within the sheath. The artery is internal, the vein external, the nerve between them, but in a posterior plane.

Relations.—*In front,* integument, fascia, platysma, sternomastoid, hyoid, thyroid, and omohyoid muscles, descendens and communicans hypoglossi nerves, sternomastoid artery, superior, middle thyroid, and anterior jugular veins, and a branch connecting anterior jugular with facial; *behind,* longus colli, rectus anticus major, spinal column, inferior thyroid artery, sympathetic and recurrent laryngeal nerves; *outer side,* internal jugular vein, vagus; *inner side,* trachea, esophagus, larynx, pharynx, thyroid gland, inferior thyroid artery, and recurrent nerve. In the lower part of the neck the internal jugular diverges from the artery on the right side, but approaches, and may cross it, on the left. The common carotid regularly gives off no branches, but a vertebral, thyroid, or laryngeal branch may arise from it on either side.

The **external carotid artery** runs from the bifurcation of the common carotid to the space between the neck of the condyle of the mandible and the auditory meatus, and there divides into the superficial temporal and internal maxillary. At its origin it is anterior and internal to the internal carotid, and at its termination is embedded in the parotid gland.

Relations.—*In front,* integument and fasciæ, sternomastoid, digastric, and stylohyoid muscles, part of the parotid gland, facial and hypoglossal nerves, lingual, facial, and temporomaxillary veins; *behind,* styloid process with its remaining muscles, part of the parotid gland, and the glossopharyngeal nerve; *internally,* pharynx, hyoid bone, part of the parotid, separating it from the lower jaw and stylomaxillary ligament, styloglossus, and stylopharyngeus muscles, and the superior laryngeal nerve.

The **branches of the external carotid,** besides those given off directly to the muscles in its course and to the parotid gland, are the following: *Anterior branches,* superior thyroid, lingual, facial; *posterior branches,* occipital, posterior auricular; *internal branch,* ascending pharyngeal; *terminal branches,* superficial temporal and internal maxillary.

I. The **superior thyroid** runs beneath the omohyoid and sternohyoid and thyroid muscles to the gland, uniting with its fellow and with the inferior thyroid. It supplies the gland, the muscles in its course, and the following named *branches:*

(*a*) *Hyoid,* to lower border of the bone, joins its fellow.

(*b*) *Superficial descending* or *sternomastoid* crosses the common carotid to the sternomastoid muscle.

(*c*) *Superior laryngeal,* beneath the thyrohyoid, pierces membrane to interior of the larynx with the superior laryngeal nerve.

(*d*) The *cricothyroid* runs across that membrane and joins its fellow.

II. The **lingual** ascends to the great cornu of the hyoid bone, runs forward parallel with it, ascends to the tongue, and runs along its under surface to the tip. It is at first superficial, lying on the middle constrictor; later covered by the digastric and stylohyoid, resting on the same muscle. It then ascends between the hyoglossus and genioglossus; finally, as the *ranine* artery, it runs on the lingualis to the tip of the tongue, along with the gustatory nerve, covered only by mucous membrane. The first part is crossed by the hypoglossal nerve. The second part is in the triangle formed by the diverging bellies of the digastric below and the hypoglossal nerve above. The artery lies above the central tendon of the digastric, below the nerve, and beneath the hyoglossus. *Branches:*

(*a*) *Hyoid,* to upper border of the hyoid bone, joins its fellow.

(*b*) *Dorsalis linguæ,* from beneath the hyoglossus, joins its fellow, and supplies the tonsil, epiglottis, and soft palate, besides the tongue.

(*c*) *Sublingual* runs on genioglossus to the gland. Branches supply the mylohyoid and gums, and a twig joins its fellow across the middle line.

III. The **facial** runs below the lower jaw upon the mylohyoid, and grooves the upper and back part of the submaxillary gland. It then crosses the jaw at the anterior border of the masseter, runs over the cheek by the angle of the mouth, and alongside of the nose to the inner canthus of the eye, ending in the angular artery, which anastomoses with the nasal branch of the ophthalmic. Its course is very tortuous.

This vessel lies at first beneath the digastric and stylohyoid, but is covered only by the platysma where it crosses the jaw. In the face it lies on the buccinator, levator anguli oris, and levator labii superioris. covered by the platysma, risorius, and zygomatici. The vein is external and at some distance from the artery, and pursues a straight course. Branches of the facial nerve cross, and the infraorbital nerve is under, the artery.

The *branches of the facial artery* are the following: A *cervical* group, including the ascending palatine, tonsillar, submaxillary, submental; and a *facial* group, the inferior labial, coronary upper and lower, lateralis nasi, and the angular and the muscular branches.

IV. The **occipital artery** is at first covered by the digastric and stylohyoid muscles and crossed by the hypoglossal nerve. It then crosses the internal carotid sheath and spinal accessory nerve to the interval between the atlas and mastoid process, lying here in the occipital groove of the mastoid process, and then pierces the origin of the trapezius to ramify in the scalp as high as the vertex. *Branches:* Muscular, the sternomastoid, the mastoid, princeps cervicis, and the meningeal.

V. The **posterior auricular artery,** resting on the styloid process, passes beneath the parotid to the groove between the mastoid and auricle, and divides into two branches, the *auricular* and the *mastoid,* the latter supplying the scalp. This artery crosses the spinal accessory and is crossed by the facial nerve.

VI. The **ascending pharyngeal** ascends between the pharynx and internal carotid to the base of the skull, giving off branches which may be divided into three sets, viz., (1) three or four *pharyngeal*, to the constrictors, the lower joining branches of the superior thyroid, and the largest to the superior constrictor, supplying also the palate and tonsil. (2) Several *meningeal* branches entering the foramen lacerum medium, jugular, and anterior condylar foramina. (3) The *prevertebral* branches, to the muscles and glands in its course and to the vagus and sympathetic nerves, anastomosing with the ascending cervical.

The external carotid divides into the superficial temporal and internal maxillary while embedded in the parotid gland, the former being the smaller.

VII. The **superficial temporal** ascends about 2 inches above the zygoma, and divides into the *anterior* and the *posterior temporal*. The former supplies the muscles, pericranium, and skin over the forehead, joining the supraorbital and frontal; the latter runs upward and backward over the side of the head, anastomosing with its fellow, the occipital, and posterior auricular. The temporal supplies the articulation of the jaw, the parotid, and the muscles in its course, and gives off the following named *branches:* (*a*) The *transverse facial*, (*b*) the *middle temporal*, and (*c*) the *anterior auricular.*

VIII. The **internal maxillary** is described in three portions—viz., maxillary, pterygoid, and sphenomaxillary. The first portion runs between the jaw and internal lateral ligament. The second runs forward and upward upon the external pterygoid. The third enters the sphenomaxillary fossa between the two roots of the external pterygoid.

Branches.—From the first or maxillary portion the tympanic, middle and small meningeal, inferior dental; from the second or pterygoid part the deep temporal, pterygoid, masseteric, buccal; from the third or sphenomaxillary part the alveolar, infraorbital, superior or descending palatine, Vidian, pterygopalatine, sphenopalatine.

(*a*) The *tympanic*, through the Glaserian fissure, joins the stylomastoid and the tympanic arteries, and supplies a *deep auricular* branch.

(*b*) The *middle meningeal* ascends between the roots of the auriculotemporal nerve, through the foramen spinosum, and divides on entering the cranium into an anterior and a posterior branch. These ramify on the inner surface of the calvaria as far as the frontal and the occipital bones, uniting with the posterior and anterior meningeal. Branches pass to the Gasserian ganglion and dura mater; through the sphenoidal fissure to the orbit; and through the hiatus Fallopii a petrosal branch passes to join a branch of the stylomastoid artery.

(*c*) The *small meningeal* enters the foramen ovale, sometimes arising from the preceding.

(*d*) The *inferior dental* traverses the dental canal, escaping at the mental foramen. It sends forward an incisor branch in the bone, gives off to the groove a mylohyoid branch, and unites with its fellow and with the submental and labial arteries. It supplies the teeth by small twigs to the roots from below.

(*e*) The two *deep temporal* anterior and posterior, join other temporal branches. The anterior sends twigs through the malar bone to unite with the lacrymal.

(*f*) The *pterygoid* branches supply the muscles of that name.

(*g*) The *masseteric* crosses the sigmoid notch to the deep surface of the muscle.

(*h*) The *buccal*, on the buccinator, joins branches of the facial.

(*i*) The *alveolar* sends branches through the posterior dental canals to the molar and bicuspid teeth, the antrum and gums.

(*j*) The *infraorbital* arises with the preceding, traverses the canal, supplying the orbital muscular branches and an anterior dental, and, escaping at the infraorbital foramen, supplies the lacrymal sac, sending branches all over the face. It joins branches of the facial and ophthalmic arteries.

(*k*) The *descending palatine* enters the posterior palatine canal, and runs along the hard palate to the anterior palatine foramen, thence through Stenson's foramen to join the nasopalatine artery. It sends branches through the accessory palatine canals to the soft palate.

(*l*) The *Vidian* passes through its canal to the pharynx and Eustachian tube, and gives a branch to the tympanum.

(*m*) The *pterygopalatine*, through its canal to the sphenoidal sinus and pharynx.

(*n*) The *nasal*, or *sphenopalatine*, through that foramen to the spongy bones, ethmoidal cells, and antrum. One large branch, the artery of the septum or nasopalatine, unites with the termination of the descending palatine artery.

The **internal carotid artery** is a very tortuous vessel, and at its origin is farther from the median line than the external carotid, deriving the name "internal" from its distribution.

For description it is divided into four parts; the first, or cervical, extends from the bifurcation of the common carotid to the carotid canal; the second, or petrous, is in the carotid canal; the third, or cavernous, runs in the cavernous sinus; and the fourth, or cerebral, is the terminal portion.

Relations.—*Cervical portion in front,* external carotid artery and its occipital and posterior auricular branches; hypoglossal, glossopharyngeal nerves, and pharyngeal branch of the vagus; *behind,* rectus capitis anticus major, sympathetic and superior laryngeal nerves; *externally,* skin and fasciæ, sternomastoid, digastric, and the styloid process with its muscles, internal jugular vein and vagus, both being in the same sheath with the artery, but having each a separate investment, the nerve being posterior to, and between, the artery and vein. Near the base of the skull the spinal accessory, glossopharyngeal, the vagus, and hypoglossal nerves emerge between the vein and artery. *Internally* the pharynx and tonsil, ascending pharyngeal artery, superior and external laryngeal nerves.

The *petrous portion* is at first in front of the tympanum and internal ear, and then runs forward and inward to the inner side of the foramen lacerum medium, and ascends, accompanied by the sympathetic, to the cavernous sinus.

The *cavernous portion* lies on the floor of the sinus, surrounded by the sympathetic, the sixth nerve being external.

The *cerebral portion* pierces the dura mater internal to the anterior clinoid process, lying at the inner extremity of the Sylvian fissure, between the second and third nerves.

The Branches of the Internal Carotid Artery.—The *first portion* gives no branches. The *second* sends a *tympanic* branch through a foramen in the carotid canal. The *third* gives off the *arteriæ receptaculi* to the pituitary gland, Gasserian ganglion, the cavernous and inferior petrosal sinuses. One of these branches is the *anterior* meningeal. It also gives off the *ophthalmic.*

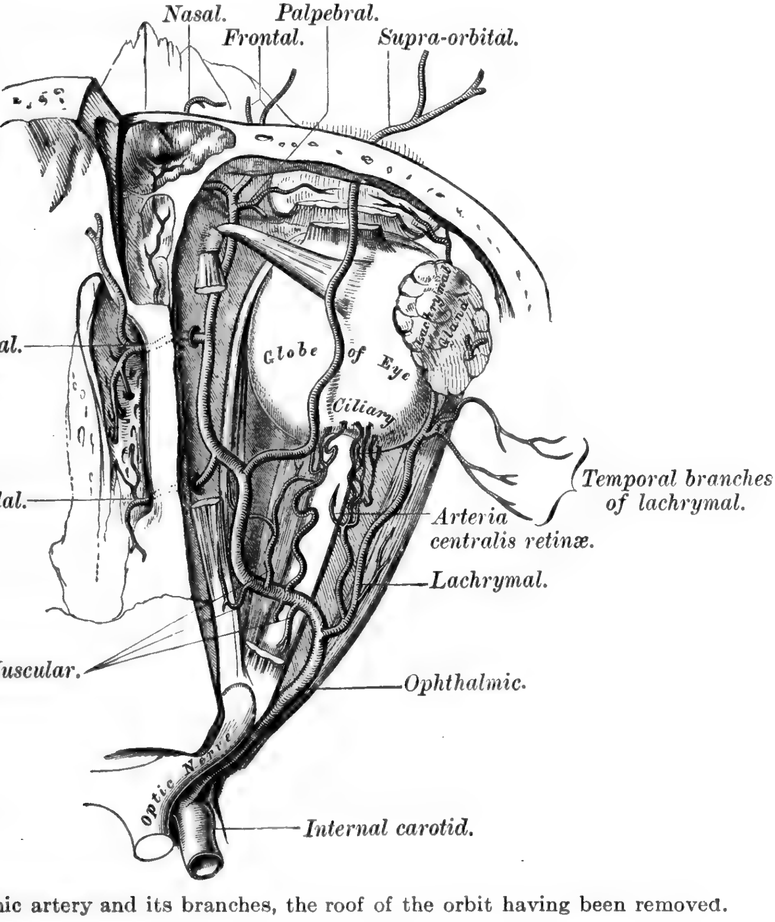
The **ophthalmic artery** passes through the optic foramen, below and external to the nerve, then crosses the latter, and runs beneath the superior oblique muscle to the inner angle of the eye, and divides into the frontal and nasal. It gives off two sets of branches, viz., *orbital* and *ocular.*

The ORBITAL branches are the following:

(*a*) The *lacrymal* runs above the external rectus to the gland, sending several malar branches through the bone to the temporal fossa and cheek, a branch back through the sphenoidal fissure to join the middle meningeal, and several to the conjunctiva and upper lid to join other palpebral vessels.

(*b*) The *supraorbital,* through the notch, joining the temporal and facial branches.

Fig. 41



The ophthalmic artery and its branches, the roof of the orbit having been removed.

(*c*) The *ethmoidal* branches, posterior and anterior, run through the ethmoidal canals to the ethmoidal cells. The former supplies also the roof of the nose; the latter runs with the nasal nerve, and divides into a meningeal and a nasal branch.

(*d*) The *palpebral* branches, superior and inferior, form arches on the lids between the orbicularis muscle and tarsal cartilages, the inferior sending a branch to the nasal duct. They anastomose with the orbital branch of the temporal and with the infraorbital artery.

(*e*) The *frontal*, at the inner angle of the orbit, unites with the supraorbital.

(*f*) The *nasal* crosses the tendo oculi to the lacrymal sac, and gives off the dorsalis nasi branch. It joins the angular artery.

(*g*) The *muscular* branches supply the muscles of the eyeball. They are superior and inferior, and belong to the ocular group.

The other OCULAR branches are:

(*h*) The *arteria centralis retinæ*, within the optic nerve to the retina.

(*i*) The *ciliary* pierce the sclerotic to supply the iris, ciliary body, and choroid. They are derived from the ophthalmic directly or from some of its branches, and are divided into the anterior set, six to eight in number; the short, ten to fifteen; and the long, two in number.

The fourth portion of the internal carotid supplies the following branches:

(*a*) The *anterior cerebral*, along the front part of the great longitudinal fissure, and is joined, by the *anterior communicating*, with its fellow. The two vessels then, side by side, curve around the front of the corpus callosum and run back over its upper surface, breaking up into terminal branches which supply the anterior cerebral lobes, anterior locus perforatus, and the optic nerves.

(*b*) The *middle cerebral*, along the Sylvian fissure to the island of Reil, supplying the pia mater over the anterior and middle lobes, as well as the anterior perforated space.

(*c*) The *posterior communicating*, running back to join the posterior cerebral.

(*d*) The *anterior choroid*, to the descending horn of the lateral ventricle, sending branches to the choroid plexus, velum, and hippocampus major.

The **subclavian arteries** are divided into three parts: the first running to the inner margin of the scalenus anticus; the second, behind that muscle; the third, from its outer border to the lower border of the first rib, where it becomes the axillary artery. The right and left vessels differ only in their first portions, the right arising behind the sternoclavicular joint, from the innominate; the left, from the aorta as a primary branch.

First Portion of the Right Subclavian.—**Relations.**—*In front,* the sternomastoid, hyoid, and thyroid muscles; deep cervical fascia; internal jugular, vertebral, and right innominate veins; and superficially, the anterior jugular vein, some loops of the sympathetic nerve and its cardiac branches, the vagus and phrenic nerves; *behind,* the transverse process of the seventh cervical or first dorsal vertebra, longus colli, recurrent laryngeal, and sympathetic nerve and pleura; *below,* the pleura and recurrent nerve.

First Portion of the Left Subclavian.—**Relations.**—*In front,* the left lung and pleura, left carotid artery; internal jugular, vertebral, and left innominate veins; vagus, phrenic, and cardiac nerves; and superficially, the sternothyroid, hyoid, and mastoid muscles; *behind,* the sympathetic nerve, esophagus, and thoracic duct, the longus colli separating it from the spine; *externally,* the pleura; *internally,* the trachea, esophagus, and thoracic duct.

Second Portion of the Subclavian.—**Relations.**—*In front,* the scalenus anticus, phrenic nerve, and the vein; *behind* and *below,* the pleura.

Third portion of the Subclavian.—**Relations.**—*In front,* the clavicle, subclavius, cervical fascia, suprascapular artery, external jugular, suprascapular, and transverse cervical veins, supraclavicular nerves from the cervical plexus, and the nerve to the subclavius; *behind,* the scalenus medius; *above,* the omohyoid, brachial plexus; *below,* the first rib.

The **branches of the subclavian** are the vertebral, thyroid axis, internal mammary, and superior intercostal. They are all derived from the first portion on the left side; on the right the superior intercostal arises from the second portion.

I. The **vertebral,** the first and largest branch, comes off from the upper and back part of the first portion and enters the transverse foramen of the sixth cervical vertebra, ascends through those of the other cervical vertebræ, and, grooving the upper border of the atlas from without, backward, and inward, around the superior articular process, pierces the dura mater. It then ascends to the front of the medulla through the foramen magnum, uniting at the lower border of the pons with its fellow to form the basilar. The thoracic duct crosses the left artery. It is at first behind the internal jugular and its own vein; then between the scalenus anticus and longus colli. In the foramina it is accompanied by a sympathetic plexus, it is in front of the spinal nerves, and it crosses the suboccipital nerve on the atlas.

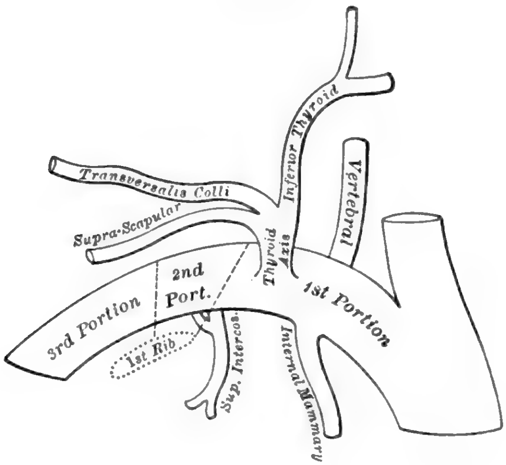
Branches.—The *cervical* branches are *muscular*, to the deep cervical region, joining the occipital and deep cervical; and the *lateral spinal*, entering the intervertebral foramina.

The *cranial* branches include:

(*a*) The *posterior meningeal*, to the falx cerebelli and cerebellar fossæ.

(*b*) The *anterior spinal*, along the front of the medulla, joins its fellow to form the upper part of the anterior median artery of the cord. This is a small vessel which runs in the anterior median fissure of the cord, beneath the pia mater, as far as the cauda equina.

Fig. 42



Plan of the branches of the right subclavian artery.

(*c*) The *posterior spinal* descends along the posterior nerve roots to the cauda equina. It is formed in a similar manner to the anterior, but it is bilateral.

(*d*) The *posteroinferior cerebellar* divides under the cerebellum into two branches. The inner runs to the notch between the hemispheres; the outer, to their under surface and the choroid plexus of the fourth ventricle, joining the superior cerebellar.

The **basilar artery**, formed by the two vertebrals, runs to the upper border of the pons, and divides into the two posterior cerebrals. It gives off the following branches:

(*a*) Several *transverse arteries* on each side. One, the auditory, enters the internal meatus; another, the *anteroinferior cerebellar,* to the anterior border of the cerebellum.

(*b*) The *superior cerebellar,* to the upper surface, joining the inferior cerebellar.

(*c*) The *posterior cerebrals,* to the under surface of the posterior lobes, receiving the *posterior communicating.* They give off the *posterior choroid* branches and supply the posterior perforated space.

The **circle of Willis** is situated at the base of the brain, it is an anastomosis formed by the bloodvessels of the brain. The arteries entering into its formation are: *In front,* the two anterior cerebral arteries, branches of the internal carotid, which are connected by the anterior communicating artery; *behind,* by two posterior cerebral arteries, branches of the basilar, and these communicate laterally with the internal carotids through the posterior communicating arteries. The parts of the brain included within this arterial circle are: The lamina terminals, the chiasm of the optic nerves, tuber cinereum, corpora albicantia, and the posterior perforated substance.

II. The **thyroid axis** arises from the forepart of the subclavian, and divides close to its origin into the inferior thyroid, suprascapular, and transverse cervical.

1. The *inferior thyroid,* to the gland behind the sympathetic and the common carotid, joins its fellow and the superior thyroid, giving off the following branches:

(*a*) Inferior laryngeal, runs with the recurrent nerve; (*b*) tracheal, joining the bronchial arteries; (*c*) esophageal; (*d*) to the inferior constrictor and hyoid depressor muscles and the scaleni; and (*e*) the ascending cervical.

The last named runs between the scalenus anticus and the rectus anticus major, joining the vertebral and giving other branches which, with the lateral spinal of the vertebral, help form the anterior median artery of the cord.

2. The *suprascapular* runs at first between the scalenus anticus and the sternomastoid, crosses the subclavian, and runs behind the clavicle to cross the transverse ligament of the scapula. In the supraspinous fossa it runs beneath the muscle, which it supplies, and crossing the neck of the scapula terminates in the infraspinatus, where it joins the dorsal and posterior scapular artery. A supraacromial branch joins the acromiothoracic

artery; a branch supplies the shoulder-joint, and another the subscapular fossa.

3. The *transverse cervical* divides at the anterior border of the trapezius into a *superficial cervical* branch, ascending beneath and supplying that muscle, and a *posterior scapular* running along the posterior border of the scapula to join the subscapular artery at its inferior angle.

III. The **internal mammary** descends from the under surface of the subclavian opposite the thyroid axis along the hinder surface of the costal cartilages, $\frac{1}{2}$ inch from the sternum, as far as the sixth interspace, and divides into the *musculophrenic* and *superior epigastric*. At first, behind the subclavian vein and the phrenic nerve, it lies against the pleura, but separated from it below by the triangularis sterni.

Branches.—(*a*) *Comes nervi phrenici,* to the diaphragm along with the nerve, joins the phrenic arteries; (*b*) *mediastinal;* (*c*) *pericardiac;* (*d*) *sternal;* (*e*) *anterior intercostal;* (*f*) *anterior* or *perforating;* (*g*) *musculophrenic;* (*h*) *superior digastric.*

IV. The **superior intercostal** crosses in front of the neck of the first rib, and supplies the first and part of the second interspace.

Its *profunda cervicis* branch passes backward between the seventh cervical vertebra and the first rib, ascends under the complexus to the axis, and joins the princeps cervicis and vertebral arteries.

THE ARTERIES OF THE UPPER EXTREMITY

The Axilla

The **axilla** is a four-sided pyramidal space, of which the sides are unequal, situated between the upper lateral aspect of the chest and the arm. Its *apex* is between the first rib, the clavicle, and the upper margin of the scapula. The *base* is directed downward and outward, and is formed by the skin and fascia stretching across between the pectoralis major and the latissimus dorsi. The *anterior wall* is formed by the pectoral muscles, the costocoracoid membrane, the clavicle, and the subclavius muscle. The *posterior wall* extends lower than the anterior, and is formed by the subscapularis above, the teres major and latissimus below. The *inner wall* is convex. It is formed by parts of the first four ribs, the portions of the intercostal muscles corresponding, and a part of the serratus magnus. The *outer wall* is narrow, because of the convergence of the anterior and posterior walls. It is formed by the humerus, coracobrachialis, and coracoid head of the biceps.

This space contains the axillary vessels and brachial plexus, with their branches, some branches of the intercostal nerve, and a large number of the lymph nodes and vessels and much fat.

The Axillary Artery

The **axillary artery** is the continuation of the subclavian. It extends from the lower border of the first rib, where it is deeply placed, to the lower border of the teres major tendon, where it is superficial, and there becomes the brachial. It is described in three parts—the first, above the pectoralis minor; the second, behind it; and the third, below it.

First Part.—**Relations.**—*In front,* pectoralis major, subclavius, costocoracoid membrane, acromiothoracic and cephalic veins, external anterior thoracic nerve; *behind,* first intercostal muscle, first digitation of the serratus magnus, posterior thoracic nerve; *externally,* brachial plexus; *internally,* axillary vein, internal anterior thoracic and posterior thoracic nerves.

Second Part.—**Relations.**—*In front,* pectoralis major and minor; *behind,* subscapularis and posterior cord of the brachial plexus; *internally,* vein and inner cord; *externally,* the outer cord.

The posterior cord of the plexus is behind it, the outer cord outside, and the inner cord to its inner side. The plexus thus surrounds the second portion of the artery.

Third Part.—**Relations.**—*In front,* integument, fasciæ, pectoralis major, median nerve, its inner head, internal cutaneous nerve; *behind,* subscapularis, tendons of the latissimus dorsi and teres major, musculospiral and circumflex nerves; *externally,* coracobrachialis, musculocutaneous, and median nerves; *internally,* the vein, brachial venæ comites, ulnar and lesser internal cutaneous nerves.

Branches.—First part, superior and acromial thoracic: second part, long and alar thoracic; third part, subscapular and circumflex, posterior and anterior.

The *subscapular* runs along the lower border of the subscapularis, joining branches with the intercostal and posterior scapular arteries. Its *dorsalis scapulæ* branch passes through a triangle formed by the two teres and the triceps, and divides into three sets, viz., dorsal, to the infraspinous fossa; ventral, to the subscapular fossa; and descending, to run between the teres muscles.

The *circumflex* arteries encircle the neck of the humerus. The *posterior,* with the nerve and veins, passes through the quadrangular space formed by the triceps, teres, and humerus, and ends in the deltoid and shoulder-joint. The *anterior,* beneath the biceps and coracobrachialis, to end under the deltoid, sends a twig to the shoulder-joint along the bicipital groove.

The Brachial Artery

The **brachial artery** extends from the end of the axillary, at the lower border of the teres major, to ½ inch below the elbow joint, dividing into the radial and ulnar arteries.

Relations.—*In front,* integument and fascia, bicipital fascia, median basilic vein, and median nerve; *behind,* triceps, coracobrachialis, brachialis anticus, musculospiral nerve, and superior profunda artery; *externally,* coracobrachialis, biceps, median nerve above; *internally,* basilic vein, venæ comites, internal cutaneous, ulnar nerve, and median nerve below.

The **branches of the brachial artery** are:

(*a*) The *superior profunda,* along the musculospiral groove, sends a branch of the shoulder-joint, anastomosing with the circumflex; the posterior articular artery, to the back of the elbow, joining the interosseous recurrent; branches to muscles; and, finally, the continuation of the vessel joins the radial recurrent in front of the outer condyle.

(*b*) The *nutrient artery,* to the humerus, enters the foramen.

(*c*) The *inferior profunda,* on the inner head of the triceps, accompanies the ulnar nerve, and divides into a branch to the front of the inner condyle and another to the back of it. The former joins the anterior, and the latter the posterior ulnar recurrent artery.

(*d*) The *muscular* branches, to the coracobrachialis, biceps, and brachialis anticus.

(*e*) The *anastomotica magna* comes off about 2 inches above the elbow and runs on the brachialis anticus inward to form an arch with the posteroarticular under the triceps. This artery forms anastomoses with all the vessels around the elbow, excepting only the radial recurrent.

The brachial divides, about $\frac{1}{2}$ inch below the elbow, into the radial and ulnar arteries.

The antecubital space or **fossa** is situated at the bend of the elbow. It is triangular in shape, the base corresponds to a line drawn between the internal and external condyles of the humerus; *externally,* the inner border of the brachioradialis or supinator longus; *internally,* the inner border of the pronator radii teres; its floor is covered by the supinator brevis and brachialis anticus, and tendon of insertion of the biceps brachii; it is enclosed by the deep fascia, a part of the bicipital fascia, superficial fascia, and the integument. It contains the brachial, radial, and ulnar arteries, and accompanying veins; the median and musculospiral nerves. The median basilic vein is separated from the brachial artery by the deep fascia of the forearm, and the bicipital fascia beneath the latter.

The Radial Artery

The **radial artery** runs from the bifurcation of the brachial along the radial side of the forearm to the wrist, and winds back to its posterior surface. It then enters the palm through the first dorsal interosseous, and runs across the hand to form the deep palmar arch by joining the deep branch of the ulnar.

In the Forearm.—**Relations.**—*In front,* integument, fascia, and supinator longus overlapping it; *behind,* from above downward, it lies on the tendon of the biceps, supinator brevis, pronator teres, flexor sublimis, flexor longus pollicis, pronator quadratus, and radius; *on the ulnar side,* flexor carpi radialis and pronator teres; *on the radial side,* supinator longus and radial nerve (its middle third).

In the wrist it lies on the external lateral ligament, scaphoid, and trapezium, and is covered by the extensors of the thumb, cutaneous veins, and by filaments of the radial and musculocutaneous nerves.

In the hand it lies on the metacarpal bones and interossei, covered by the flexor tendons, opponens, flexor brevis minimi digiti, and flexor brevis pollicis.

The **branches of the radial artery** are divided into three groups:

I. *In the forearm:* (*a*) The *radial recurrent,* between the supinator longus and the brachialis anticus, joins the superior profunda.

(*b*) The *muscular,* to the radial side of the forearm.

(*c*) The *superficialis volæ,* through the muscles of the thumb; sometimes it ends in them, or it may be very large, or may complete the superficial arch.

(*d*) The *anterior carpal* runs inward to join in the anterior carpal arch with the ulnar branch.

II. *In the wrist:* (*e*) The *posterior carpal* joins the ulnar branch, forming the posterior carpal arch. This arch gives off the third and fourth dorsal interosseous branches.

(*f*) The *metacarapl* runs on the second dorsal interosseous muscle, and joins, by branches, the first superior perforating and palmar digital arteries. It divides into two dorsal digital branches for the index and middle fingers, their adjacent sides, and it also gives off an inferior perforating artery to the corresponding palmar digital.

(*g*) Two *dorsales pollicis,* along the sides of the thumb.

(*h*) The *dorsalis indicis,* along the radial side of the index finger.

III. *In the hand:* (*i*) The *princeps pollicis,* along the ulnar side of the first metacarpal to the proximal phalanx, where it divides into two branches for the palmar sides of the phalanges.

(*j*) The *radialis indicis,* along the radial border of the palmar surface of the index finger.

(*k*) The superior perforating arteries pass back between the heads of the last three dorsal interossei muscles to join the dorsal interosseous arteries.

(*l*) Three or four palmar interosseous branches join the palmar digital arteries at the finger clefts.

The Ulnar Artery

The **ulnar artery** runs along the inner side of the forearm to the wrist, crosses the annular ligament and the palm of the hand, and joins the superficialis volæ to form the superficial arch.

In the Forearm.—**Relations.**—*In front,* integument, fascia, and superficial flexor muscles, median nerve, and palmar cutaneous branch of the ulnar nerve; *behind,* brachialis anticus, flexor profundus digitorum; *ulnar side,* flexor carpi ulnaris, median nerve above and ulnar nerve below; *radial side,* flexor sublimis.

At the wrist the nerve is internal to the artery, and the pisiform bone is internal to the ulnar nerve.

In the hand, as the superficial arch, it is covered by the skin, palmaris brevis, and palmar fascia. It rests on the annular ligament, superficial tendons, and divisions of the median and ulnar nerves.

The **branches of the ulnar artery** are divided into three groups:

I. *Forearm:* (*a*) The *anterior ulnar recurrent,* to front of the inner condyle, joins the anastomotica magna and inferior profunda.

(*b*) The *posterior ulnar recurrent,* beneath the flexor sublimis to the back of the inner condyle, and between the heads of the flexor carpi ulnaris along the ulnar nerve; joins the posterior interosseous recurrent and inferior profunda arteries.

(*c*) The *interosseous,* to the upper border of the interosseous membrane, where it divides into the anterior and posterior interosseous arteries. The anterior runs on the front of the membrane, which it pierces above the pronator quadratus, to join the posterior branch and the posterior carpal arch. It supplies the *median artery* to the nerve, muscular branches, and the nutrient vessels of the radius and ulna. A branch joins the anterior carpal arch. The *posterior interosseous* descends along the back of the forearm, between the superficial and deep muscles, and joins the anterior. It gives off the *interosseous recurrent,* which ascends beneath the anconeus to join, behind the olecranon, in the anastomosis at the elbow-joint.

(*d*) The *muscular,* to the ulnar side of the forearm.

II. *Wrist:* The *anterior* and *posterior carpal* join similar branches of the radial to form the carpal arches, the posterior giving a metacarpal branch to the little finger, ulnar side.

III. *Hand:* (*a*) The *deep branch* joins the radial to form the palmar arch.

(*b*) The *digital* branches from the superficial palmar arch are four, going to the little, ring, middle, and ulnar side of the index finger.

The Thoracic Aorta

The **thoracic aorta** descends from the lower border of the fifth to the front of the last dorsal vertebra.

Relations.—*In front,* root of the left lung, pericardium, and esophagus; *behind,* azygos minor vein and spinal column; *to the left,* left lung and pleura, and, below the esophagus; *to the right* esophagus above, vena azygos major, thoracic duct.

The **branches of the thoracic aorta**:

(*a*) The PERICARDIAC.

(*b*) The BRONCHIAL, to the bronchial glands and the esophagus; they are also the nutrient vessels of the lung. The right sometimes arises from the first aortic intercostal.

(*c*) Four or five ESOPHAGEAL, joining the inferior thyroid above, the gastric and phrenic below.

(*d*) The POSTERIOR MEDIASTINAL.

(*e*) The INTERCOSTAL. These are nine or ten, the superior intercostal from the subclavian supplying the upper space or two. They cross obliquely to the edge of the rib above, running at first on the external, and then between the two sets of intercostal muscles.

Each divides into two branches running along the contiguous borders of the two ribs, and each uniting anteriorly with the corresponding branch of the anterior intercostals from the internal mammary.

A posterior branch runs from each, and divides into a spinal branch to the cord and a muscular branch.

The Abdominal Aorta

The abdominal aorta runs from the last dorsal to the left side of the middle of the body of the fourth lumbar vertebra, there dividing into the two common iliacs.

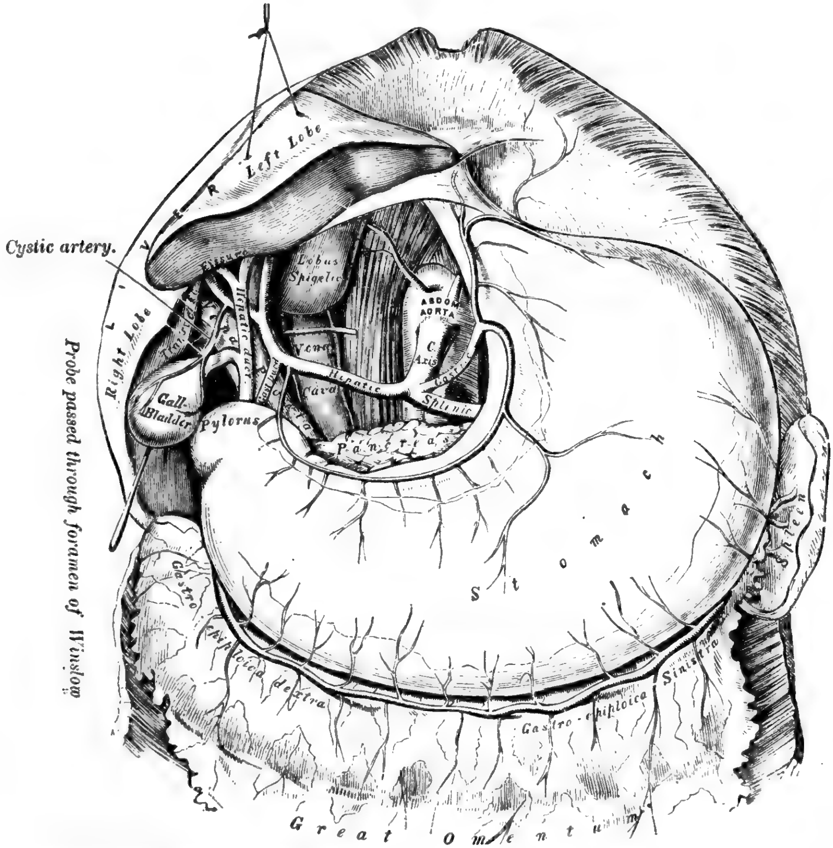
Relations.—*Infront,* lesser omentum, stomach, pancreas, transverse duodenum, left renal and splenic veins, peritoneum forming mesentery, aortic, and solar plexuses; *behind,* receptaculum chyli, thoracic duct, left lumbar veins, and spine; *to the right,* crus of the diaphragm, vena cava, great azygos vein, thoracic duct, right semilunar ganglion, splanchnic nerve; *to the left,* splanchnic nerve, left semilunar ganglion.

The **branches of the abdominal aorta**:

(*a*) Parietal and (*b*) visceral.

The **parietal branches** are: I. The **phrenic,** a right and a left. Their origin is inconstant, from the aorta separately or in common, or from one of its branches. They run across the crura to the under surface of the diaphragm. Each supplies suprarenal capsular branches, the right sending branches to the liver and vena cava; the left, to the spleen and esophagus.

Fig. 43



The celiac axis and its branches, the liver having been raised and the lesser omentum removed.

II. The **lumbar**, five on each side, pass behind the psoas and sympathetic, and divide into a *dorsal* branch to the back, and an *abdominal* branch running between the abdominal muscles, joining branches of the epigastric, intercostal, iliolumbar, and internal mammary.

III. The **middle sacral**, along the middle of the front of the sacrum to the coccyx, joining the lateral sacral and entering Luschka's gland.

The **visceral branches**: I. The **celiac axis,** $\frac{1}{2}$ inch long, divides into the *gastric, hepatic,* and *splenic.* It is covered by the lesser omentum, rests below on the pancreas; on each side is a semilunar ganglion, and on the right the lobus Spigelii, on the left the stomach.

Branches.—(*a*) The *gastric* artery runs to the cardiac orifice, thence to the right, along the lesser curvature, in the lesser omentum as far as the pylorus. It supplies both surfaces of the stomach and the esophagus, anastomosing with the splenic, pyloric branch of the hepatic, and esophageal arteries.

(*b*) The *hepatic* artery passes below the foramen of Winslow to the pylorus, then ascends in the lesser omentum, anterior to that foramen, and to the left of the gall duct, to the transverse fissure of the liver, and divides into a *right* and a *left* branch. Its *pyloric* branch passes along the lesser curvature to meet the gastric. Its *cystic* branch from the right division ascends on the neck of the gall-bladder and supplies it by two branches. The other branch of the hepatic, the *gastroduodenalis,* divides behind the lower part of the duodenum into a *superior pancreaticoduodenal* branch, descending between the pancreas and duodenum to join the inferior artery of the same name; and the *gastroepiploica dextra,* passing into the omentum toward the left, along the great curvature, to meet the sinistra.

(*c*) The *splenic* runs tortuously to the left, along the upper border of the pancreas, and divides near the spleen into branches which enter at the hilum, some passing to the stomach.

Branches.—Pancreatic, numerous, small; and one larger, the *pancreatica magna,* accompanies the duct of Wirsüng.

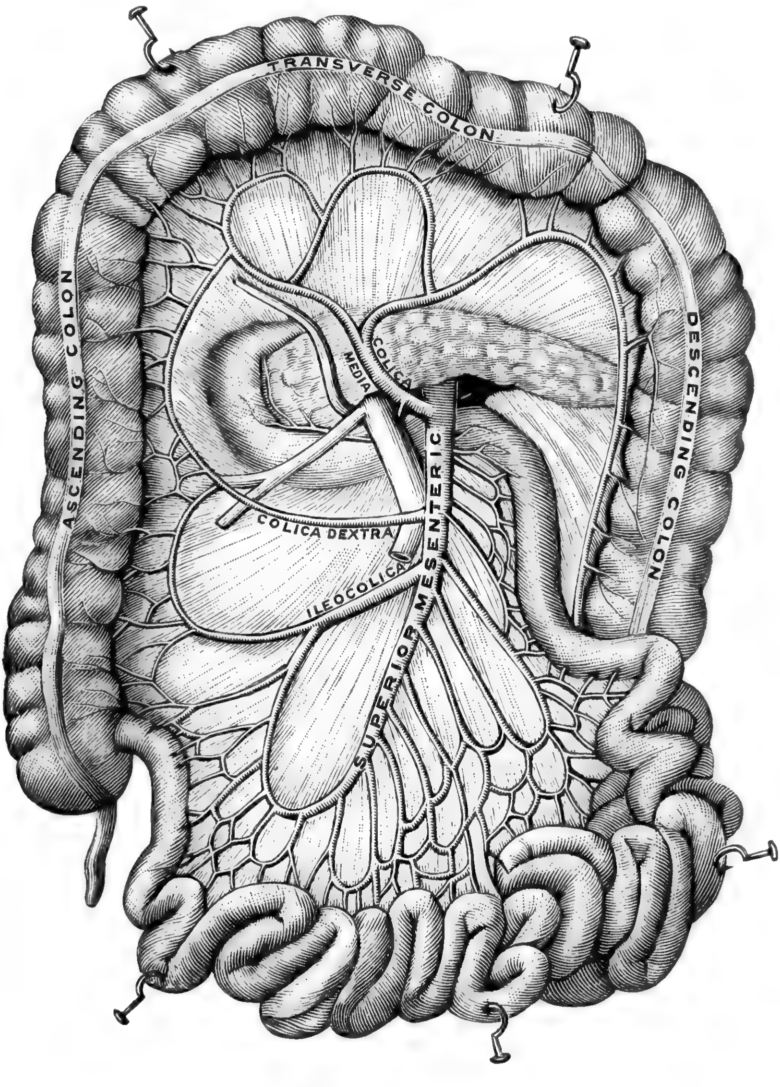
Five to seven *vasa brevia,* in the gastrosplenic omentum, to the great end of the stomach, joining the gastric and gastroepiploic vessels.

The *gastroepiploica sinistra* runs to the right, along the great curvature, to join the dextra.

II. The **superior mesenteric** supplies the small intestine except the first part of the duodenum, as well as the cecum, and ascending and transverse colon. Emerging from between the transverse duodenum and pancreas, it crosses the former, and descends in the mesentery to the right iliac fossa with its veins and a plexus of nerves. It ends by anastomosing with its own iliocolic branch.

Branches.—(*a*) The *inferior pancreaticoduodenal,* joining the superior from the hepatic artery.

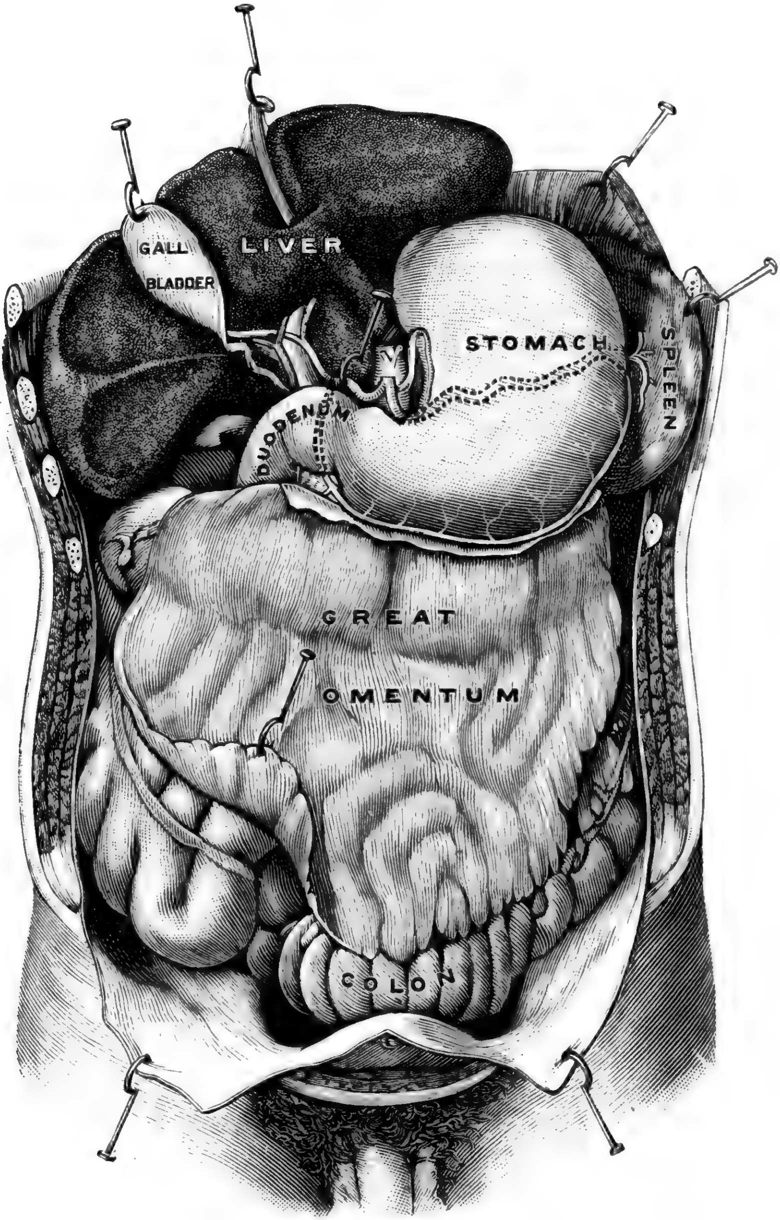
Fig. 44



Superior mesenteric artery. (Testut.)

(*b*) Twelve to fifteen *vasa intestini tenuis* to the jejunum and ileum, running parallel within the mesentery, each vessel bifurcating. These divisions, uniting on each side with their fellows, complete a series of arches from which are formed, similarly,

Fig. 45



Arteries of the stomach, liver, and great omentum. (Testut.)

secondary arches. The terminal arches send numerous straight vessels around the gut.

(*c*) The *iliocolic* divides near the right iliac fossa into two branches. The inferior joins the termination of the superior mesenteric; the upper joins the colica dextra. It supplies the ileum, cecum, appendix, and ascending colon.

(*d*) The *colica dextra,* to the middle of the ascending colon, divides into a lower branch joining the iliocolic, and an upper which joins the colica media. These branches form arches from which is supplied the colon.

(*e*) The *colica media,* to the transverse colon, divides into a right branch joining the dextra; a left, the sinistra.

III. The **inferior mesenteric** supplies the descending colon and its continuation. Arising from the left side of the aorta an inch or two above the bifurcation, it passes to the left iliac fossa, ending in the pelvis as the superior hemorrhoidal. It gives off the following *branches:*

(*a*) The *colica sinistra,* to the descending colon, dividing into an upper branch joining the media; a lower, the sigmoid artery.

(*b*) The *sigmoid,* to the flexure, joins the colica sinistra above and the superior hemorrhoidal below.

(*c*) The *superior hemorrhoidal,* in the mesorectum, crosses the left common iliac artery and vein. It divides into two branches, one on each side of the rectum, which finally join the middle and inferior hemorrhoidal arteries.

IV. The **suprarenals,** to the under surface of the suprarenal capsules, join branches of the phrenic and renal arteries.

V. The **renal,** to the hilum, enters by four or five branches into which each vessel divides close to the kidney. They lie between the veins in front and the ureters behind. Branches pass to the suprarenal bodies and ureter. There may be more than one renal on each side.

VI. The **spermatic,** the **ovarian** in the female, to the testicles or ovaries respectively. Passing behind the peritoneum, they cross the ureter and psoas, and in front of the vena cava on the right, each crossing also the external iliac vessels. In the male the vessel then runs through the inguinal canal to the testis, joining the artery of the vas deferens. In the female it runs in the broad ligament to the ovary, and sends branches to the broad ligament, the tubes, and uterus.

The Iliac Arteries

The common iliac arteries run downward and outward from the division of the aorta to the lumbosacral joint, and divide into the external and internal iliacs.

Relations.—Each has *in front* the peritoneum, small intestine, ureter, and sympathetic nerve; the left is crossed by the superior hemorrhoidal artery; *behind* and to the *inner* side of each is its vein, the right having both its own and the left vein between it and the last lumbar vertebra, and external to each is the psoas magnus. The right at its upper part has also the beginning of the inferior vena cava posteriorly.

Branches.—Small twigs to the psoas, ureters, and lymphatic glands.

The **internal iliac artery** descends to the upper part of the great sacrosciatic foramen, and divides into an anterior and a posterior trunk.

Relations.—*In front,* the ureter and peritoneum; *behind,* the sacrum, lumbosacral cord, companion vein, and the external iliac vein at its upper part; *internally,* the vein; *externally,* the psoas muscle. The *posterior trunk* gives off the following *branches:* (*a*) the **iliolumbar**; (*b*) the **lateral sacral**; (*c*) the **gluteal,** passes through the great sciatic foramen, and divides into a superficial and a deep branch.

The *anterior trunk* of the internal iliac gives off the following *branches:*

(*a*) The **superior vesical** represents the pervious part of the fetal hypogastric artery. It runs to the apex and body of the bladder and to the ureter, joins its fellow, and gives off the *artery* of the *vas deferens,* which accompanies that structure to the testis. It also generally gives off the (*b*) middle vesical to the base of the bladder.

(*c*) The **inferior vesical**—**vaginal** in the female—joins its fellow. It supplies the bladder, prostate gland, and seminal vesicles; in the female, vagina and rectum.

(*d*) The **middle hemorrhoidal** arises with the preceding, and runs to the rectum to join other hemorrhoidal arteries.

(*e*) The **uterine** in the female ascends in the broad ligament from the cervix along the side of the uterus and gives off a branch to the ovary, which anastomoses with the ovarian artery;

branches to the cervix of the uterus, **cervicouterine**, and a branch which descends on the vagina, **cervicovaginal**, and, joining with branches from the vaginal arteries, form a median longitudinal vessel both in front and behind; these continue on the anterior and posterior surfaces of the vagina, and are called the **azygos arteries of the vagina.**

(*f*) The **obturator** runs forward below the pelvic brim, between the peritoneum and pelvic fascia below the nerve, then through the upper part of the obturator foramen, dividing beneath the obturator externus into an *external* and an *internal* branch. Skirting the edges of the foramen, they join below with each other and the internal circumflex. The external also joins the sciatic, and sends a branch along the ligamentum teres, through the cotyloid notch, to the joint.

The termination of the anterior trunk of the internal iliac then divides into two branches, the sciatic and the internal pudic arteries.

(*g*) The **internal pudic** escapes from the pelvis through the great sciatic foramen, crosses the ischial spine, and re-enters the pelvis by the lesser foramen, then runs along the outer wall of the ischiorectal fossa an inch and a half above the tuberosity, and upon the rami of the ischium and pubes, to the subpubic arch, where it divides into the artery of the corpus cavernosum and the dorsal artery of the penis.

This vessel is at first in front of the pyriformis, the sacral plexus intervening, and external to the rectum. On the ischial spine it lies beneath the gluteus maximus, the pudic nerve internally. In the ischiorectal fossa it lies on the obturator internus, ensheathed by the obturator fascia, then between the layers of the perineal fascia.

Branches.—(*a*) Two or three *inferior hemorrhoidal*, to skin and muscles around the anus.

(*b*) The *superficial perineal* runs over or under the transversus perinei to the back of the scrotum, sending branches to the skin and muscles of the perineum.

(*c*) The *transverse perineal*, to the parts between the anus and bulb, joins its fellow.

(*d*) The *artery of the bulb* runs in the constrictor urethræ, pierces the bulb, and sends a branch to Cowper's gland.

(*e*) The *artery of the corpus cavernosum* runs forward in the centre of that body after piercing the crus penis.

(*f*) The *dorsal artery of the penis* runs between the symphysis and the penis to the glans and prepuce. Here it is superficial, and lies upon the crus penis, pierces the suspensory ligament, and runs along the dorsum between the median vein and the corresponding nerve.

In the female the pudic artery is smaller, but has analogous branches. The superficial perineal artery runs to the labia; that of the bulb to the bulbus vestibuli; that of the corpus cavernosum to the corresponding part of the clitoris; and the dorsal artery to the glans clitoridis.

(*g*) The **sciatic** accompanies the pudic, resting on the pyriformis muscle and the sacral plexus, escapes by the great foramen, and descends, midway between the tuber ischii and the trochanter major, with the sciatic nerves.

The *branches* are: (*a*) the *coccygeal,* (*b*) the *muscular,* (*c*) the *comes nervi ischiadici,* (*d*) the *anastomotic,* (*e*) the *articular* branches.

The **external iliac artery** extends from the division of the common iliac to the mid-point between the symphysis of the pubis and the anterior superior spine of the ilium, behind Poupart's ligament.

Relations.—*In front,* the peritoneum, subperitoneal fascia, sigmoid flexure on the left, ileum on the right side, lymphatic vessels and glands, spermatic or ovarian vessels, deep circumflex iliac vein, genital branch of the genitocrural nerve and, at times, the ureter; *behind,* psoas muscle and iliac fascia and its vein; *internally,* its vein and the vas deferens; *externally,* psoas and iliac fascia.

The **branches of the external iliac artery**: (*a*) The **deep epigastric** descends to Poupart's ligament, then ascends, internal to the deep ring, between the transversalis fascia and the peritoneum. It then pierces the fascia and enters the sheath of the rectus, ascending on the posterior surface of the muscle, and dividing into branches which join the superior epigastric. The vas deferens in the male, round ligament in the female, cross the vessel on its outer side at the internal ring.

Branches.—The *cremasteric,* to the cord; the *pubic,* to the back of the pubis, joining the pubic of the obturàtor; and the *muscular.*

(*b*) The **deep circumflex iliac** passes to the anterior superior spine in a sheath of the transversalis and iliac fascia, thence along the inner margin of the crest. On a line with the anterior superior spine of the ilium it ascends between the transversalis and internal oblique muscles.

THE ARTERIES OF THE LOWER EXTREMITY

The Femoral Artery

The **femoral artery** continues the external iliac artery down into the thigh to end at the opening in the adductor magnus at the junction of the upper three-fourths and lower one-fourth of the femur. From its beginning to the point where the profunda femoris is given off, it is called the common femoral, below this the superficial femoral. Its upper part lies in *Scarpa's triangle,* bounded above by Poupart's ligament, the inner side formed by the inner margin of the adductor longus, the outer by the sartorius. Its floor, from without inward, is made up of the iliacus, psoas, pectineus, and adductor brevis. The lower part runs in Hunter's canal, a depression between the vastus internus and the adductores magnus and longus, covered by a strong fascia passing between them, the latter covered by the sartorius muscles.

Relations.—*In front,* fascia lata, crural sheath, fascia covering Hunter's canal, sartorius, internal cutaneous and long saphenous nerves, nerve to the vastus internus, and filaments of the crural branch of the genitocrural nerve, and a few superficial veins; *behind,* psoas magnus, pectineus, adductores brevis, longus and magnus, femoral vein and profunda vessels, branch of the anterior crural nerve to the pectineus; *outer side,* anterior crural nerve, vastus internus, and femoral vein below; *inner side,* sartorius, adductor longus, femoral vein above.

The *branches of the femoral artery* are: (*a*) The **superficial epigastric** rises about half an inch below Poupart's ligament and passes through the sphenous opening, ascends in the superficial fascia over the abdomen, joining other epigastrics.

(*b*) The **superficial circumflex iliac.**

(*c*) The **superior external pudic** comes off from the inner side of the common femoral a little below the preceding and passing through the saphenous opening crosses to the lower abdomen over the cord, supplying the penis and scrotum (the labium in the female).

(*d*) The **inferior external pudic** arises close to the superior, crosses the pectineus, pierces the fascia lata at the margin of the groin, and supplies the perineum and scrotum (the labium in the female).

(*e*) The **muscular branches** all along its course.

(*f*) The **anastomotica magna** arises close to the adductor opening, and divides into two branches: a deep, to the inner side of the knee, joins the recurrent tibial and articular arteries, and a superficial, which runs with the long saphenous nerve.

(*g*) The **profunda artery** arises from the femoral at its outer and back part, one to two inches below Poupart's ligament. It at first runs outward, but afterward behind the femoral, then beneath the adductor longus, terminating at the lower third of the thigh by piercing the adductor magnus, becoming the lowest perforating artery.

Relations.—*In front,* adductor longus, femoral and profunda veins; *behind,* iliacus, pectineus, adductores magnus and brevis; *externally,* vastus internus.

Branches.—The *external circumflex* runs beneath the sartorius and rectus, and divides into—ascending branches, under the tensor vaginæ to join the gluteal and deep circumflex iliac arteries; descending branches, running upon the vasti, some passing beneath to the knee, to join the articular arteries; transverse, piercing the vastus externus to the back of the femur, and joining the superior perforating.

The *internal circumflex* runs between the psoas and pectineus, and supplies the adductor and obturator muscles and an articular twig to the hip-joint, under transverse ligament. It then joins in the crucial anastomosis, which is situated in the upper part of the thigh posteriorly, covered by the gluteus maximus. It is formed by the joining of this artery with the sciatic from above, the superior perforating below, and the external circumflex to the outer side.

The *perforating* pierce the short and great adductor muscles close to the femur, to the back of the thigh, anastomosing freely with each other and with the popliteal below. The superior enters into the crucial anastomosis. The first arises above the adductor brevis, the second opposite, the third below it. The second or third gives the nutrient artery to the femur. The termination of the profunda is called the fourth perforating.

The Popliteal Space

The popliteal space is lozenge-shaped, being widest at the back part of the knee-joint and deepest above the articular end of the femur. It is **bounded** *externally, above the joint,* by the biceps, and *below the joint* by the plantaris and external head of the gastrocnemius; *internally, above the joint,* by the semitendinosus, semimembranosus, gracilis, and sartorius; *below the joint,* by the inner head of the gastrocnemius.

Above, it is limited by the apposition of the inner and outer hamstring muscles; *below,* by the junction of the two heads of the gastrocnemius. The *floor* is formed by the lower part of the posterior surface of the shaft of the femur, the posterior ligament of the knee-joint, the upper end of the tibia, and the fascia covering the popliteus muscle, and the space is *covered* in by the fascia lata.

The Popliteal Artery

The popliteal artery runs from the adductor opening to the lower border of the popliteus, where it divides into the anterior and posterior tibial.

Relations.—*In front,* femur, ligamentum posticum, popliteus; *behind,* semimembranosus, fascia, gastrocnemius, plantaris, and soleus, popliteal and short saphenous veins, and the internal popliteal nerve; *outer side,* external condyle, outer head of the gastrocnemius, plantaris, internal popliteal nerve above; *inner side,* inner condyle, inner head of the gastrocnemius, semimembranosus, popliteal vein, and the internal popliteal nerve below.

The **branches of the popliteal artery** are:

(*a*) **Muscular superior,** three or four, to the lower part of the hamstring muscles to join the inferior perforating; **inferior** (sural), to the upper part of the gastrocnemius, plantaris, and soleus.

(*b*) **Cutaneous** to the skin of the calf.

(*c*) **Articular superior,** two in number, an external and an internal, wind around above the condyles to the front. The external gives a branch to the external vastus and one to the joint, and also forms an arch with the anastomotica. The internal gives a branch to the internal vastus, joining anastomotica and inferior articular, and another to the knee-joint, and also unites with the inferior articular.

(*d*) The **azygos articular** pierces the posterior ligament to the joint.

(*e*) **Articular inferior** wind around the tibia below the joint. They are external and internal, and anastomose with the tibial recurrent, anastomotica, and other articular branches.

The **anterior tibial artery** runs from the lower border of the popliteus, between the heads of the tibialis posticus and above the interosseous membrane, to the front of the leg, then descends as far as the ankle, ending in the *dorsalis pedis*.

Relations.—*In front,* integument, fascia, tibialis anticus, extensores proprius pollicis and longus digitorum, anterior tibial nerve; *behind,* interosseous membrane, tibia, anterior tibiotarsal ligament; *outer side,* extensores proprius pollicis and longus digitorum, anterior tibial nerve; *inner side,* tibialis anticus, tendons of extensor proprius pollicis below.

Its *branches* are:

(*a*) The **recurrent tibial,** through the tibialis anticus to the knee, joins other articular arteries.

(*b*) The **muscular,** to the muscles and skin: very numerous.

(*c*) The **malleolar,** to the ankle-joint. *Internal* joins corresponding branches of the posterior tibial; *external* joins the tarsal and anterior peroneal.

The **dorsalis pedis** is the continuation of the anterior tibial, and runs from the bend of the ankle to the first interosseous space, where it divides into the *dorsalis hallucis* and *plantar digital.*

Its *branches* are:

(*a*) The **tarsal.**

(*b*) The **metatarsal,** over the bases of the metatarsal bones, joins the tarsal and external plantar, and gives off three *dorsal interosseous arteries* which run in the outer three intermetatarsal spaces, each dividing opposite the metatarsophalangeal joint into two *dorsal digital* branches. These arteries anastomose at back part of spaces with the posterior perforating, and at front part with the anterior perforating.

(*c*) The **dorsalis hallucis** lies along the first intermetatarsal space, and supplies both sides of the great toe and the inner side of the second dorsally.

(*d*) The **plantar digital** passes between the heads of the first dorsal interosseous, joins with the external plantar to form the plantar arch, and after supplying the inner side of the great toe divides into two branches for the adjacent sides of the great and second toes.

The **posterior tibial artery** runs from the lower border of the popliteus to divide, between the inner malleolus and heel, into the *external* and *internal plantar* arteries.

Relations.—*In front,* tibialis posticus, flexor longus digitorum, tibia, and ankle joint; *behind,* skin, fascia, gastrocnemius, soleus, deep transverse fascia, posterior tibial nerve. This nerve is internal in its upper part, but lower down it is external to the artery.

Its *branches* are:

(*a*) The **peroneal** runs from one inch below the popliteus to the lower third of the leg, and divides into the *anterior* and *posterior peroneal.* It is covered by the soleus and deep transverse fascia; in front of it are the tibialis posticus and interosseous membrane; external to it, the fibula; and externally, as well as behind, the flexor longus pollicis.

The peroneal gives off *muscular* branches and a *nutrient artery* to the fibula. The *anterior peroneal* passes beneath the interosseous membrane to the front of the leg, and runs to the outer ankle to join the tarsal and external malleolar. The *posterior peroneal* passes down behind the external malleolus, and terminates in branches (*external calcaneal*) which anastomose with the external malleolar.

(*b*) The **nutrient artery** for the tibia.

(*c*) The **muscular branches.**

(*d*) The **communicating.**

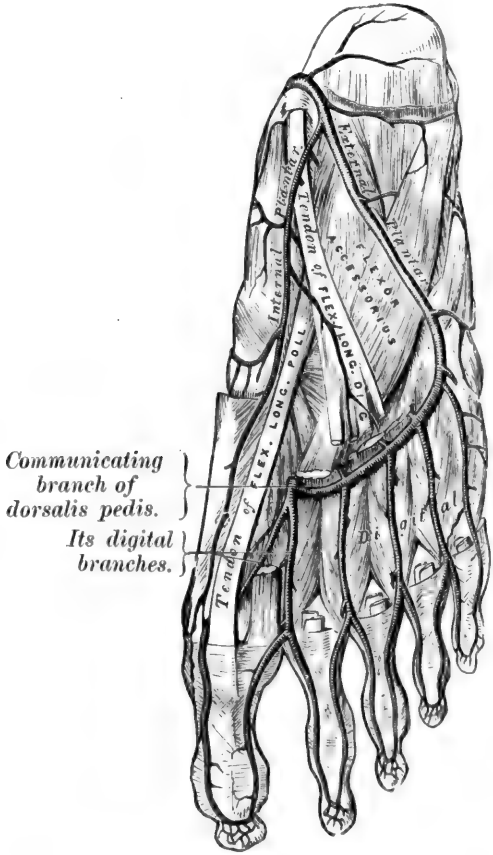
(*e*) Several **internal malleolar.**

The **plantar arteries** are the terminal branches of the posterior tibial. The **internal** is at first under cover of the abductor pollicis, and then between it and the flexor brevis digitorum, anastomosing at the inner border of the great toe with its digital artery.

The **external,** the larger, passes to the base of the fifth metatarsal, then to the space between the first and second metatarsals, and joins the plantar digital, from the dorsalis pedis, to form the plantar arch.

The **plantar arch** supplies the muscles, fascia, and skin of the sole of the foot, and gives off the *posterior perforating*. These pierce the three outer spaces between the heads of the dorsal interossei and join the dorsal interosseous arteries.

FIG. 46



The plantar arteries. Deep view.

The *digital*, four in number, supply the three outer toes and the outer half of the second toe; the first runs to the outer side of the little toe, the others bifurcate to the adjacent sides of the fourth and fifth, fourth and third, third and second toes. At the point of bifurcation each sends a small branch to join the dorsal interosseous arteries (*anterior perforating*).

THE VEINS

The veins, like the arteries, are of two great systems, the pulmonary and the systemic.

THE PULMONARY VEINS

These are four large trunks, two on each side, which return the blood from the lungs to the left auricle. On the right side they pass behind the right auricle and superior vena cava; on the left, in front of the descending aorta. The upper right vein receives the branch from the middle lobe.

THE SYSTEMIC VEINS

The **veins of the heart** are:

The **great cardiac** vein ascends in the anterior interventricular groove from the apex of the heart to the left auriculoventricular groove; along this latter it runs to the posterior surface of the heart, to end in the coronary sinus. At its termination it is provided with a valve.

Three or four **posterior cardiac** veins ascend on the left ventricle to the sinus.

The **middle cardiac** vein ascends in the posterior interventricular groove to the sinus.

The **right (small) coronary** vein in the right auriculoventricular groove to the sinus.

The **coronary sinus,** one inch long, is placed at the back part of the auriculoventricular groove, on the left side, and opens into the right auricle in front of the inferior vena cava. Besides the foregoing veins, it receives the *oblique vein* of Marshall, which drains the back of the left auricle. Its opening is guarded by the Thebesian valve.

The other cardiac veins are several small vessels from the front of the right ventricle, the **anterior cardiac** veins, opening directly into the auricle, and the **venæ Thebesii,** in the muscular substance, which open by minute orifices, the foramina Thebesii, near the septum auricularum.

The Superior Vena Cava and Innominate Veins

The **superior vena cava** is a large trunk formed by the union of the two venæ innominatæ, and returns the blood from the head and neck, the thoracic walls, and the upper extremities. It is about three inches long, and descends from the junction of the first right costal cartilage with the sternum to its termination in the right auricle, opposite the upper border of the third right cartilage.

At first it is external to the innominate artery and internal to the right phrenic nerve, partly covered by the pleura. It then pierces the pericardium external to the ascending aorta, having descended in front of the right division of the pulmonary artery. It receives the azygos major and small pericardiac and mediastinal veins.

The **innominate veins**, formed by the union of the subclavian and internal jugular of each side, behind the inner end of the clavicle unite to form the superior vena cava. The right vein, one inch long, descends vertically on the right side of the innominate artery, while the left, more than two inches in length, descends slightly, running to the right, behind the sternohyoid and thyroid muscles and upper part of the sternum. The transverse aorta lies below it.

Each receives the *vertebral, inferior thyroid,* and *internal mammary* veins. The left vein also receives the *superior intercostal* and some small *thymic, mediastinal,* and *pericardiac* veins and the thoracic duct, while the right is joined at its origin by the right lymphatic duct.

The **vertebral** vein descends with the artery of the same name through the foramina in the transverse processes of the upper six cervical vertebræ, crosses the subclavian artery, and opens into the back part of the vena innominata.

The **inferior thyroid veins** arise by tributaries from the lateral lobes of the thyroid gland, and descend on the trachea beneath the sternothyroid muscles. The left joins the innominate on its own side, sometimes in common with the right. The latter may empty into the junction of the two venæ innominatæ or join the right vena innominata.

The **internal mammary veins** are two on each side, and accompany the artery, receiving *corresponding* tributaries, finally uniting to form a single trunk which joins the corresponding innominate.

The **superior intercostal vein** drains the two or three spaces *below* the first, and enters on the right side the large azygos; on the left side it communicates with the left upper azygos and joins the innominate.

THE VEINS OF THE HEAD AND NECK

The **facial vein** runs from the inner angle of the eye to the anterior border of the masseter muscle, then backward below the jaw, joining the anterior division of the temporomaxillary trunk to form the common facial, which joins the internal jugular. It sends a *communicating tributary* along the front of the sternomastoid to the anterior jugular. At its origin it is continuous with the *angular,* a vein formed by the union of the *frontal* and *supraorbital.*

The **temporomaxillary vein** (**posterior facial**) is a short trunk, formed by the *temporal* and *internal maxillary* veins, runs from opposite the condyle of the lower jaw to the angle of the jaw, and divides into an anterior branch joining the facial and a posterior branch running backward to form with the posterior auricular the external jugular. This vein is embedded in the parotid gland external to the external carotid artery.

The **temporal vein** is formed by the union of the *superficial* with the *middle temporal* vein, and crosses over the zygoma and under the parotid to join the internal maxillary vein. It receives the *anterior auricular, parotid,* and *transverse facial* veins, and tributaries from a plexus around the articulation of the jaw.

The **internal maxillary vein** arises from the pterygoid plexus and runs in company with the first part of the artery, joining the temporal vein behind the ramus of the jaw.

The **posterior auricular vein** descends over the mastoid process and sternomastoid and ends in the external jugular.

The **occipital veins,** two or three, join the deep cervical vein.

The emissary vein in the mastoid foramen connects the lateral sinus with the most external of the occipital veins.

The **external jugular vein** is formed by the union of the posterior auricular and the posterior division of the temporomaxillary trunk. It descends obliquely across the sternomastoid, lying between the platysma and fascia. Above the clavicle it pierces the fascia and joins the subclavian at the outer border of the scalenus anticus; sometimes it joins the internal jugular. It receives the *posterior external jugular, anterior jugular, transverse cervical,* and *suprascapular* veins. The two latter correspond to the arteries of the same name.

The *posterior external* jugular drains the occipital and posterior cervical regions.

The *anterior jugular* descends along the front of the neck from the submaxillary region, pierces the fascia near the inner end of the clavicle, and joins the external jugular, sometimes the subclavian. This vein and its fellow are joined by a cross-branch just above the sternum, and it receives tributaries of communication from the submental, external jugular, and facial.

The **internal jugular vein** commences at the jugular foramen just below the junction of the inferior petrosal with the lateral sinus, and descends with the external carotid, then with the common carotid, to join at a right angle with the subclavian vein behind the clavicle, thus forming the innominate vein. It is placed external to the carotid vessels, lying in the same sheath with each in turn.

It receives the following tributaries:

The *common facial* (*vide antea*) and the *middle thyroid.*

The *superior thyroid.*

The *pharyngeal veins.*

The *lingual veins,* including the *ranine, dorsal vein of the tongue,* and the *venæ comites* of the lingual artery.

The *inferior petrosal sinus* is regarded by some anatomists as the first tributary.

The **cerebral veins.** These are divided into two sets, the superficial and the deep.

Superficial Veins.—The *superior,* ten to twelve on each side, consist of the anterior, middle, and posterior veins which run in the sulci, and, joining with branches from the mesial aspect of the brain, empty into the superior longitudinal sinus. The *inferior* consists of the middle cerebral vein, in the Sylvian fissure, which joins the cavernous sinus, and the great anastomotic vein, in the posterior branch of the same fissure, communicating with the middle meningeal veins and joining the superior petrosal sinus.

Deep Veins.—They finally converge to two trunks, the *vena Galeni.* These run backward in the velum interpositum, the right and left, lying side by side, and unite into the *vena magna Galeni,* which joins the straight sinus. Each vena Galeni is formed by the union of the *choroid* vein and the *vena corporis striati,* and is joined by the *basilar* and other small veins, while the vena magna receives tributaries from the occipital lobes of each side and from the upper surface of the cerebellum.

The **cerebellar veins** are divided into two sets, the superior and the deep.

The *superior* join the straight sinus and the vena magna internally, and the superior petrosal and lateral sinuses externally.

The *inferior* enter the inferior petrosal, lateral, and occipital sinuses along with branches from the medulla and pons.

1. **The Cranial Sinuses.**—The **superior longitudinal sinus** is contained in the upper border of the falx cerebri, and extends from the crista galli to the torcular Herophili. Its section is triangular, and its cavity is crossed by several fibrous bands, the chordæ Willisii, and contains some Pacchionian bodies. It grooves the frontal, parietal, and occipital bones. In front a small vein in the foramen cecum connects it with the nasal veins, and through the parietal foramen it communicates with the veins of the scalp. The superior cerebral veins open into the sinus, looking forward contrary to the direction of the blood current. At its termination it enlarges and becomes continuous with the right (usually) or left lateral sinus. From this dilatation (the torcular Herophili) a cross-branch passes to join the straight sinus.

2. The **inferior longitudinal sinus,** in the lower border of the falx cerebri, runs back to join the straight sinus.

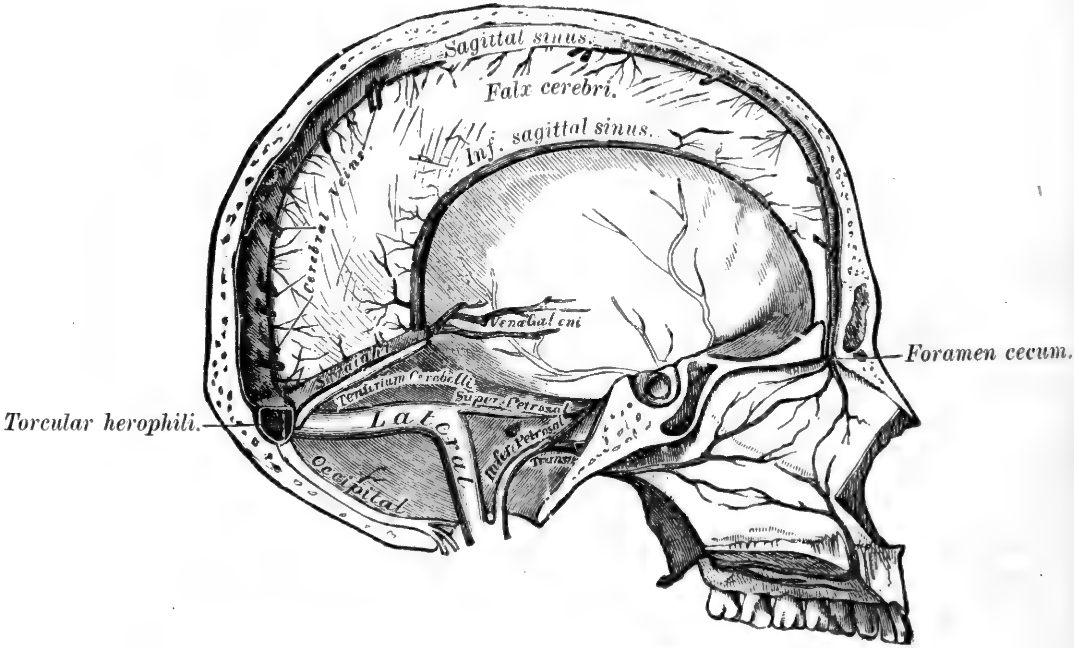
3. The **straight sinus** continues the inferior longitudinal along the line of junction of the falx with the tentorium backward, and joins the lateral sinus opposite to that in which the superior longitudinal ends. It receives the vena magna Galeni, some superior cerebellar veins, and a cross-branch from the torcular Herophili.

4. The **lateral sinuses** run in the attached margin of the tentorium from the internal occipital protuberance to the jugular foramen, grooving, in order, the occipital, parietal, mastoid portion of the temporal and the occipital a second time. Each

sinus receives the superior petrosal sinus and emissary veins from the mastoid and posterior condylar foramina, as well as some cerebellar, diploic, and posterior cerebral veins.

5. **Occipital sinus,** small, sometimes double, is contained in the falx cerebelli, and opens into the torcular above and the lateral sinus below by a branch on each side of the foramen magnum. It receives some cerebellar veins and branches from the posterior spinal veins.

Fig. 47



Vertical section of the skull, showing the sinuses of the dura mater.

6. The **cavernous sinuses,** one on each side of the body of the sphenoid, run from the sphenoidal fissure to the apex of the petrous portion of the temporal, receiving the ophthalmic veins in front and joining the petrosal sinuses behind. It receives the sphenoparietal sinus, some inferior cerebral veins, and is joined with the opposite vessel by the circular sinus.

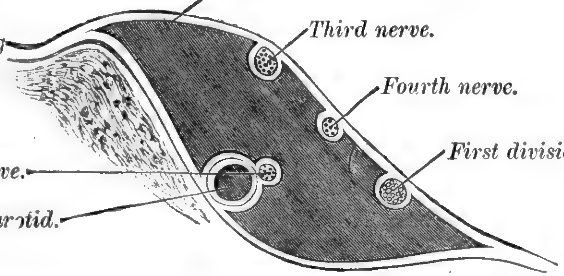
7. The **circular sinus** consists of the anterior and posterior intercavernous sinuses, which join at each end the cavernous sinuses, thus surrounding the pituitary body.

8. The **superior petrosal sinus** runs from the cavernous sinus, along the upper border of the petrous portion of the temporal,

to end in the lateral sinus at the fossa sigmoidea. It receives the inferior cerebral, superior cerebellar, and some tympanic veins.

9. The **inferior petrosal,** in the groove between the basilar process and petrous portion, runs from the cavernous to join the lateral sinus at the jugular foramen, completing the internal jugular vein. (See under Internal Jugular Vein.) It receives the auditory and some inferior cerebellar veins.

FIG. 48



Showing the relative position of the structures in the right cavernous sinus, viewed from behind.

10. The **transverse** (basilar) **sinus** is a plexus in the dura mater over the basilar process. It joins the anterior spinal veins below and the two inferior petrosal sinuses laterally.

The **ophthalmic veins** are superior and inferior.

The **superior** passes back from the root of the nose with the ophthalmic artery through the sphenoidal fissure to the cavernous sinus.

The **inferior** runs back, near the floor of the orbit, to open into the cavernous sinus, sometimes joining the superior.

The **diploic veins** run between the tables of the skull and open into the dural sinuses or externally.

The **emissary veins** are small veins connecting the cranial sinuses with the veins outside by means of foramina in the bones. These are the principal: one each—

(*a*) Through the mastoid foramen, from the lateral sinus to the outermost occipital vein.

(*b*) Through the posterior condylar foramen, from the lateral sinus to the cervical venous plexus.

(*c*) Through the parietal foramen, from the superior longitudinal to the veins of the scalp.

(*d*) Through a foramen in the external occipital protuberance to the occipital veins.

(*e*) Through the foramen ovale, from the cavernous to the pterygoid plexus.

(*f*) Through the foramen lacerum medium, from the cavernous sinus to the pharyngeal plexus.

(*g*) Through the carotid canal, a small plexus from the cavernous sinus to the internal jugular.

(*h*) Through the anterior condylar foramen, a plexus from the occipital sinus to the deep cervical veins.

THE VEINS OF THE UPPER EXTREMITY

The **superficial veins** commence from a plexus on the dorsum of the hand mostly, but to some extent from the palm. They comprise the following:

The **ulnar**, *anterior* and *posterior*, uniting above in the common ulnar.

The **radial** vein is situated on the outer side, and the **median** ascends mesially, receives a *deep median* vein, and divides at the bend of the elbow into the median basilic and median cephalic.

The **median basilic** joins the common ulnar to form the basilic. The bicipital fascia separates it from the brachial artery.

The **median cephalic** crosses the external cutaneous nerve, and joins the radial to form the cephalic.

The **basilic** runs along the inner side of the biceps, pierces the fascia, and is continued upward into the axillary vein.

The **cephalic** runs along the outer side of the biceps, and between the pectoralis major and deltoid, piercing the costocoracoid membrane to join the axillary vein below the clavicle.

The **deep veins** of the upper extremity are the **venæ comites.** They run one on each side of its artery from the digital to the brachial arteries. The venæ comites of the latter vessel, at the lower border of the subscapularis muscle, empty into the axillary vein.

The **axillary** vein begins where the venæ comites of the brachial artery and the basilic vein unite. It runs internal to the artery, and receives veins corresponding to its branches, as well as the cephalic.

The **subclavian** vein is the continuation upward of the axillary, and runs at a lower level than its artery, from which it is separated by the phrenic nerve and scalenus anticus, to the inner border of that muscle, to join the internal jugular, forming the innominate. It receives the *external jugular,* and occasionally the *anterior.*

THE VEINS OF THE TRUNK

The **azygos veins** are three in number.

I. The right, or **vena azygos major,** commences by the *right ascending lumbar vein.* Ascending to the thorax through the aortic opening and on the bodies of the dorsal vertebræ to the fourth, it arches over the root of the right lung and joins the superior vena cava above the pericardium. It receives the *right superior intercostal vein* and the remaining *right intercostal* veins save the *first,* the *left azygos,* the *right bronchial,* and some *esophageal, posterior mediastinal,* and *pericardiac* veins. Below it communicates with the common iliac by means of the ascending lumbar.

II. The **vena azygos minor inferior** vein commences as the *left ascending lumbar,* and ascends through the left crus and along the spine to the ninth dorsal vertebra. It then crosses to the right, behind the aorta, and joins the vena azygos major. It receives the *lower three* or *four intercostals* and some *mediastinal* veins.

III. The **vena azygos minor superior** vein is formed by the *fourth intercostal* to the *eighth* inclusive, and joins the large azygos. It receives the *mediastinal* tributaries, *left bronchial* vein, and communicates above with the *left superior intercostal.*

The *intercostal veins* lie above the arteries.

The *bronchial veins* return part of the blood from the bronchial arteries. The right joins the vena azygos major; the left, the left upper azygos.

The **spinal venous system** is made up as follows: (*a*) The **dorsal spinal** veins; (*b*) the **venæ basis vertebræ;** (*c*) the **anterior longitudinal spinal** veins; (*d*) the **posterior longitudinal spinal** veins, and (*e*) the **veins of the cord,** which run tortuously in pia mater, one larger vein along the anterior fissure.

The Inferior Vena Cava

This large trunk arises at the fifth lumbar by the union of the two common iliacs. It ascends to the right of the aorta, grooves the posterior border of the liver, pierces the diaphragm, is enclosed by the serous layer of the pericardium, and empties into the right auricle. The Eustachian valve guards its orifice. It receives the following tributaries:

(*a*) The **lumbar,** corresponding to the arteries.

(*b*) The **spermatic** forms within the spermatic cord a plexus, the spermatic or pampiniform, which runs with the spermatic artery through the inguinal canal, ending in several vessels uniting into a single trunk. This vein, the spermatic, ascends on the psoas behind the peritoneum, and joins the vena cava on the right, the renal vein on the left side.

In the female its analogue, the **ovarian** vein, forms the pampiniform plexus in the broad ligament and runs with the artery.

(*c*) The **renal veins** run from the hilus of the kidney, in front of the arteries, to join the vena cava at a right angle. The left is longer and crosses the aorta. This vein receives some small suprarenal branches and also the spermatic and suprarenal veins.

(*d*) The **suprarenal** run from the suprarenal bodies to the vena cava on the right, the renal on the left side.

(*e*) The **inferior phrenic.**

(*f*) The **hepatic veins,** two or three, join the vena cava at the groove in the liver through which the latter passes.

The **common iliac veins** are formed by the junction of the external and internal iliacs; they run from the base of the sacrum to the upper part of the fifth lumbar vertebra, and unite to form the inferior vena cava. The right is the shorter, and is at first behind, later to the right, of its artery, while the left is internal to its own artery, then behind the right iliac artery. The common iliacs receive the following tributaries:

The **iliolumbar.**

The **two middle sacral,** one on each side of the artery, anastomose with the lateral sacral and hemorrhoidal veins, and unite into a single vessel which joins the left common iliac vein.

THE VEINS OF THE LOWER EXTREMITY

The **superficial veins** begin on the dorsum of the foot in a plexus which receives the digital veins, and forms an arch from which emerge the internal or long and the external or short saphenous veins.

The **long (internal) saphenous,** from the inner part of the plexus, runs in front of the inner malleolus, along with the long saphenous nerve, behind the inner border of the tibia and condyle of the femur; thence up along the anterointernal part of the thigh to join the femoral vein at the saphenous opening. It communicates with the deep plantar, both tibial, and the femoral veins, and receives superficial plantar and cutaneous tributaries, and the *superficial circumflex iliac, epigastric,* and *external pudic* veins.

The **short (external) saphenous** vein ascends behind the outer malleolus, and external to the tendo Achillis, with the external saphenous nerve, and pierces the deep fascia in the popliteal space to join the popliteal vein. It receives branches from the heel and back of the leg and from the deep veins and the long saphenous.

The **deep veins** are the *venæ comites* of the arteries. The **posterior tibial veins** receive the **peroneal,** and join the **anterior tibial** to form the **popliteal.** This vessel then ascends, crossing superficial to the artery, from the inner to the outer side, and becomes the femoral at the adductor opening. It receives the *external saphenous* and veins corresponding to the arterial branches.

The **femoral vein** accompanies the artery, and becomes the external iliac at Poupart's ligament. It is at first outside, then behind, and at its termination internal to the artery. It receives, in its lower part, veins corresponding to the branches of the superficial femoral artery; the *long saphenous,* and the *profunda* vein. The latter is formed by the union of the *venæ comites* of the offsets of the *profunda* artery.

The **external iliac** runs to join the internal iliac near the lumbosacral articulation, being at first internal to, later behind, the artery. It receives the *deep circumflex iliac,* the *deep epigastric,* and a *pubic* vein.

THE VEINS OF THE PELVIS

The **internal iliac vein** accompanies the artery, lying behind and to its inner side, to join the external at the base of the sacrum, forming the common iliac. Its tributaries correspond to the branches of the artery in a general way. Thus it receives the following *tributaries:*

The *gluteal, sciatic,* and the *obturator;* the *lateral sacral,* which form a plexus on the sacrum and open into the internal iliac at several points; the *internal pudic,* which receives branches corresponding to the *perineal* branches of the artery and commences as the *vein of the corpus cavernosum.*

The *dorsal vein of the penis,* at first two veins, these uniting into one, which runs back between the two dorsal arteries in a median groove, passes below the subpubic ligament and divides into two veins, joining each side of the prostatic plexus, and each division communicating with the obturator and pudic veins of each side.

The **visceral veins** are larger than the arteries, and communicate freely with one another, so as to form a series of **plexuses,** as follows:

The *prostatic plexus,* continuous above with the vesical plexus, is formed by the dorsal vein of the penis and branches from the prostate and its vicinity. It communicates with the radicles of the pudic vein. This plexus has its analogue in the female around the urethra, which receives the *dorsal vein of the clitoris.*

The *vesical plexus* extends over the body and base of the bladder, and communicates with the prostatic and hemorrhoidal plexuses; vaginal in the female.

The *hemorrhoidal plexus,* in the wall of the lower rectum, beneath the mucous coat, sends out *superior, middle,* and *inferior hemorrhoidal* veins, which follow the corresponding arteries, and communicate freely with the other plexuses.

The *vaginal plexus* surrounds the lower part of the vagina, and communicates with the vesical and hemorrhoidal plexuses, and the *uterine plexus* empties into the ovarian vein.

THE PORTAL SYSTEM

The *portal system* consists of the veins which drain the gall-bladder, stomach, spleen, pancreas, duodenum, jejenum, ileum, cecum, colon, and upper portion of the rectum; these tributaries usually bear the same names as the arteries, which they accompany. However, the portal vein is found, directly, by the splenic and superior mesenteric veins joining behind the neck of the pancreas, also the gastric, pyloric, cystic, and parumbilical veins open into it before reaching the transverse fissure of the liver.

The **portal vein,** 3 inches long, ascends behind the duodenum and between the layers of the lesser omentum. Here it runs behind the hepatic artery and bile duct. Accompanied by the hepatic plexus of nerves and lymphatics, all enclosed in Glisson's capsule, it then enters the transverse fissure, forming near the right end the "sinus," and divides into: A *right* branch, to the right lobe, which distributes branches entering the hepatic substance with the hepatic arterial branches and ducts; and a *left* branch distributed like the right.

The **superior mesenteric,** corresponding to the artery of the same name, receiving also the *right gastroepiploic vein,* besides branches accompanying those of the artery. It joins the splenic vein.

The **splenic** arises by five or six vessels uniting after leaving the hilum, and runs to the right below the artery, joining the above at a right angle to form the vena portæ. It receives the *vasa brevia, left gastroepiploic,* and *pancreatic branches,* and the inferior mesenteric vein.

The **inferior mesenteric** vein corresponds in branches and course to the artery, and empties into the angle of junction of the two preceding.

The **gastric** vein accompanies the gastric artery and runs along the lesser curvature of the stomach between the two layers of the gastrohepatic omentum, it receives some esophageal veins near the esophageal end of the stomach and then runs from left to right posterior to the lesser peritoneal cavity to open into the portal vein.

The **pyloric** runs with the pyloric branch of the hepatic artery, and joins the vena portæ.

The **cystic** vein drains the gall-bladder and accompanies the gall-duct to open into the right branch of the portal vein.

The **parumbilical** veins are small veins found in the urachus and ligamentum teres, which establish an anastomosis between the anterior abdominal wall and the portal and iliac veins. They are best seen from the umbilicus upward, running along the round ligament, then between the layers of the falciform ligament, to end in the left branch of the portal vein.

THE ABSORBENT OR LYMPHATIC SYSTEM

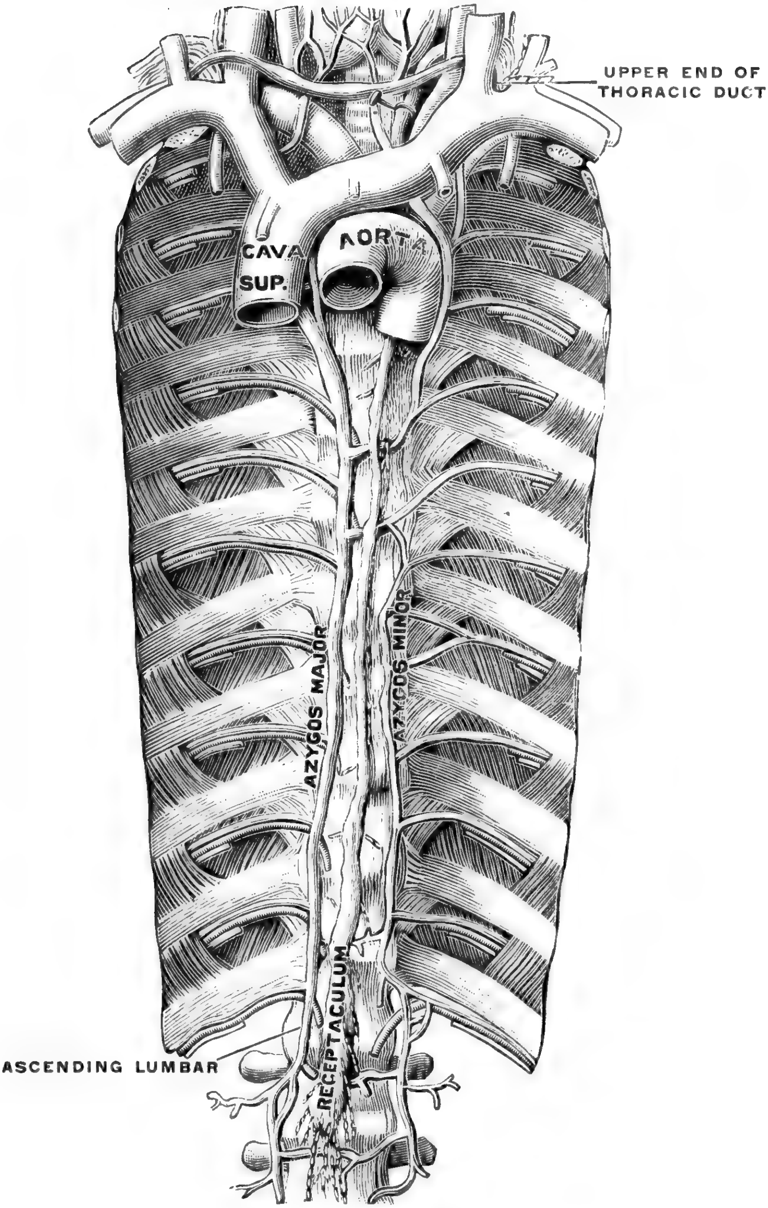
The absorbent system consists of vessels resembling thin-walled veins, the *lymphatics,* interrupted at intervals by the *lymphatic nodes.* The lymphatics of the alimentary canal are called *lacteals.* All these vessels converge to two principal trunks, the *thoracic duct* and the *right lymphatic duct,* which open into the large veins at the root of the neck.

The Thoracic Duct

The thoracic duct is the common trunk of all the lymphatic vessels of the body, excepting those which drain the right side of the head and neck, the right upper extremity, the right lung, right side of the heart, and part of the convex surface of the liver. It is from 15 to 18 inches in length, in the adult, and begins as the **receptaculum chyli.** The duct extends from the second lumbar vertebra to the root of the neck, where it empties into the angle of junction of the left internal jugular and subclavian veins. It is placed in front of the dorsal vertebræ and passes to the thorax through the aortic opening between the aorta and vena azygos major. It then runs upward toward the left, behind the arch of the aorta (at the fourth dorsal vertebra), then between the esophagus and left subclavian artery, and at the seventh cervical vertebra it arches over the pleura to join the angle of union between the left subclavian and internal jugular veins.

The right lymphatic duct collects the lymph from the parts just mentioned above. It is only one-half inch or less in length, and empties on the right side, at a point corresponding to that where the thoracic duct empties on the left side.

Fig. 49



Thoracic duct, azygos and intercostal veins. (Testut.)

THE LYMPHATIC VESSELS AND NODES OF THE LOWER EXTREMITY

The lymphatics of the lower limb are arranged in a *superficial* and a *deep* set. The former open, in general, into the *superficial inguinal* nodes; the latter into the *deep inguinal* nodes. The superficial follow, in a general way, the course of the long saphenous vein; the deep accompany the deep bloodvessels, and in the leg enter the *popliteal nodes;* in the gluteal and adductor region some enter the internal iliac nodes.

The superficial lymphatics of the lower part of the trunk also join the superficial inguinal nodes. The superficial lymphatics of the penis enter the superior set of superficial inguinal nodes; the deep run under the pubic arch to join the internal iliac nodes. The superficial lymphatics of the scrotum join the superficial inguinal nodes. In the female external genitalia a similar disposition obtains.

The *superficial inguinal nodes,* eight or ten, consist of a *superior* or oblique set in the line of Poupart's ligament, and an *inferior* or vertical set lying around the upper part of the saphenous vein. Efferent vessels join the deep inguinal and external iliac nodes.

The four or five *popliteal* nodes surround the vessels, and receive the deep and some superficial absorbents of the leg.

The *deep inguinal glands* lie around the femoral vessels; one at the crural ring is constant.

THE LYMPHATIC VESSELS AND NODES OF THE PELVIS AND ABDOMEN

These include the following:

Six or more *external iliac* nodes surround these vessels.

Numerous *internal iliac* nodes, and sacral glands on the face of the sacrum.

The lymphatics of the *bladder* enter the internal iliac nodes with the *prostatic* branches.

The lymphatics of the *uterus,* with those of the *vagina,* to the internal iliac nodes.

The lymphatics of the *rectum* enter the sacral node.

The *lumbar* nodes comprise a middle and two lateral groups. The former lie around the aorta and vena cava, the latter beneath the psoas. Most of the efferent vessels join to form, on each side, the *lumbar lymphatic trunk,* which runs into beginning of the thoracic duct.

The lymphatics of the *kidney,* deep and superficial, join the middle lumbar set after receiving the suprarenal lymphatics and some from the ureter.

The lymphatics from the *testicles,* superficial and deep, through the inguinal canal, in the cord, to join the lumbar nodes.

The *deep lymphatics* of the *abdominal wall* receive others from the spinal canal and muscles, and join the lateral lumbar nodes. At the upper part they enter the sternal nodes.

About one hundred and fifty *mesenteric* nodes lie between the layers of the mesentery in the arterial arches and around the superior mesenteric artery.

The *lacteals* form one plexus beneath the mucous membrane and one in the muscular coat, and leave the intestine at the attachment of the mesentery to enter the mesenteric nodes, and, emerging, join the efferent vessels from the celiac nodes and form a single trunk. This intestinal lymphatic trunk joins the thoracic duct.

Sixteen to twenty *celiac* nodes, around the celiac axis and adjacent aorta, receive the lymphatics from the stomach, spleen, pancreas, and a large part of the liver.

The lymphatics of the *stomach* traverse the gastric nodes at the greater and lesser curvature and join the celiac nodes. From the left end they join the splenic lymphatics.

The lymphatics of the *spleen,* superficial and deep, enter the celiac nodes after receiving the pancreatic vessels.

The lymphatics of the *liver* are superficial and deep. The superficial on the upper surface are arranged in four groups: (1) The mesial, from both lobes, run through the diaphragm to the anterior mediastinal nodes; (2) the lateral of each lobe to the celiac nodes; (3) the posterior, through the diaphragm to the nodes around the inferior vena cava; (4) an anterior group joins those on the inferior surface.

The superficial lymphatics on the lower surface run to the transverse fissure, for the most part, to join with the deep lymphatics. Some join the gastric lymphatics.

The deep hepatic lymphatics accompany the portal and hepatic veins. The former join the other vessels from the under surface at the transverse fissure, and traverse some small hepatic nodes to join the celiac nodes. Those accompanying the hepatic veins form five or six trunks piercing the diaphragm, and join the glands around the vena cava.

THE LYMPHATIC SYSTEM OF THE THORAX

This is composed of six to ten *internal mammary* or sternal nodes along the course of the vessels.

Along the line of the heads of the ribs, on each side of the spine, are the *intercostal* nodes. They send vessels to both the thoracic and right lymphatic ducts.

Several *anterior mediastinal* nodes lie between the sternum and the pericardium.

Eight or ten *superior mediastinal* or *cardiac* nodes, around the great vessels, receive the lymphatics of the heart and thymus gland.

Numerous *bronchial* nodes, between the bronchi and along their primary divisions, receive the lymphatics of the lung. They deepen in color as age advances.

Ten or twelve *posterior mediastinal* nodes, along the esophagus and aorta.

The *deep lymphatics* of the *chest wall* are an anterior set, in the intercostal spaces, joining the internal mammary nodes, and a posterior or intercostal set, along with the intercostal vessels, joining the intercostal nodes.

The *cardiac lymphatics* run toward the base of the heart, and form a trunk on each side. Of these, the right enters a node above the aortic arch—the left, the nodes behind that vessel.

The *pulmonary lymphatics,* superficial and deep, end in the bronchial nodes.

The *esophageal lymphatics* form a plexus between the muscular and mucous coats and join the posterior mediastinal nodes.

The *thymic lymphatics* enter the superior mediastinal nodes.

THE LYMPHATICS OF THE UPPER LIMB

These consist of a superficial and a deep set, both converging to the axillary glands. The former have a somewhat similar distribution to that of the veins, some entering the infraclavicular glands; the latter correspond to the deep bloodvessels, communicate with the superficial lymphatics near the wrist, traverse the glands around the brachial artery near the elbow, and end in the axillary.

The **axillary nodes** are ten to twelve in number, and lie mostly along the axillary vessels; but some, the *pectoral, subscapular,* and *infraclavicular,* occupy the positions indicated by their names. The efferent vessels from all these glands run along the subclavian vein, and may unite into a single axillary lymphatic trunk. They finally reach the thoracic or right lymphatic duct respectively; or they may enter the subclavian vein directly.

The *superficial lymphatics* of the *chest* drain the lymph from the pectoral muscles, skin, and mamma, and together with some superficial abdominal lymphatics enter the axillary glands. Those from the *back* converge from all parts to reach the axillary glands.

THE ABSORBENT SYSTEM OF THE HEAD AND NECK

This consists of the following:

One or more *suboccipital* nodes on the complexus send branches to the cervical nodes.

Several *mastoid* nodes over the insertion of the sternomastoid.

Some *parotid* nodes, beneath the parotid fascia and embedded in the node, receive superficial temporal lymphatics, and send branches to the submaxillary and superficial cervical nodes.

The *internal maxillary* nodes, deep beneath the ramus of the jaw, around the artery and side of the pharynx, with branches to the deep cervical nodes.

Eight or ten *submaxillary* nodes beneath the base of the jaw drain the lymph from the floor of the mouth and the salivary glands and from the parotid lymphatic nodes. The efferent vessels join the superficial and deep cervical nodes.

The *superficial cervical* nodes, four to six, along the external jugular beneath the platysma, receive the auricular lymphatics, efferent trunks from the suboccipital, mastoid, and some from the parotid and submaxillary nodes. The efferent vessels enter the inferior deep cervical nodes.

The *deep cervical*, twenty to thirty, consist of an upper and a lower set. The former run along the internal jugular vein; the latter around the lower part of the vein and into the supraclavicular fossa, and join the superior mediastinal and axillary nodes; they receive afferent trunks from all the other cervical nodes and the lymphatics of the lower part of the neck, and send out branches which unite into a *jugular lymphatic trunk.* This trunk then joins the thoracic or right lymphatic duct, or may open into a large vein.

The *lymphatics* of the *scalp* join the suboccipital, mastoid, and parotid nodes.

The *lymphatics* of the *face* follow the course of the facial vein to the submaxillary nodes, but there are others externally which join the parotid nodes. The *deep* lymphatics from the *orbit, nasal cavity, palate,* and *cheek* join the internal maxillary nodes.

The *cranial lymphatics* form a network in the pia mater, and run along the internal carotid, vertebral, and internal jugular veins to the deep cervical nodes.

The *lingual lymphatics* run with the ranine vein, traverse several lingual nodes, and join the upper deep cervical nodes. One or two join the submaxillary.

The retropharyngeal nodes are found in the buccopharyngeal fascia behind the pharynx and in front of the arch of the atlas, however, separated from the latter by the rectus capitis anticus major. They drain the nasal fossæ, the nasopharynx, and the Eustachian tube, as far as the tympanum; then their efferents pass to the upper set of deep cervical modes.

Which auricular appendix is the more anterior?
Which ventricle forms the apex of the heart?
Which surface of the heart rests on the diaphragm?

THE ARTERIES

Of what are the bronchial arteries branches?
Of what are the coronary arteries branches?
Name in order the branches of the transverse aortic arch.
How do the subclavians differ from each other?
Of what are the vertebral arteries branches?
Opposite what point does the common carotid divide?
What relation does the external carotid bear to the internal in the neck.
Of what is the lingual artery a branch, and where does it come off?
Describe precisely the course and relations of the lingual artery.
Name the branches of the inferior thyroid artery.
Of what is the posterior scapular artery a branch?
What structure loops around the occipital close to its origin?
Describe the relation of the internal maxillary artery to the external pterygoid muscle.
How is the basilar artery formed?
Describe the circle of Willis.
Describe the ophthalmic artery and its branches.
How is the facial artery situated with reference to its vein?
Where can the facial artery be readily felt and compressed?
Describe the origin and course of the internal mammary arteries.
Where does the axillary artery begin and end?
Which division of the axillary artery is in relation to the cords of the brachial plexus, and what is that relation?
Describe the axillary space, giving location and direction of apex and base, and describe its walls.
Describe the relation of the lower division of the axillary artery and the brachial artery to the median nerve.
What structures does the radial artery lie upon above the wrist?
What separates the radial artery from the skin?
What separates the ulnar artery from the skin?
Of what is the common interosseous artery a branch?
To which side of the radial artery is nerve of same name?
To which side of the ulnar artery is the nerve of that name?
Of what artery is the superficial palmar arch principally formed?
Locate both palmar arches on your own hand.
Of what are the superior intercostal arteries branches?
To which side of the external abdominal ring is the deep epigastric artery?
Opposite what point of the anterior abdominal wall does the aorta bifurcate?
What position does the hepatic artery occupy in the lesser omentum?
Where does the common femoral artery end?
Of what are the circumflex arteries branches?
State the boundaries of Scarpa's triangle, and give in order the muscles in its floor.

What muscles enter into the formation of Hunter's canal?

What muscles is the profunda femoris in relation with?

What arteries form the crucial anastomosis?

What are the branches of the popliteal artery?

Is the anterior tibial artery in direct relation with the interosseous membrane?

How does the anterior tibial artery get to an anterior position, and what relation does it bear, in its upper part, to the anterior tibial nerve?

Is the posterior tibial artery on the interosseous membrane; if not, where is it?

Give the courses and relations of the internal and external plantar arteries.

THE VEINS

How many pulmonary veins are there?

What forms the superior vena cava?

What are large veins in the dura mater called?

Where and how is the internal jugular vein formed?

How is the axillary vein formed?

Where does the cephalic vein empty?

Where does the inferior vena cava enter the pericardium, and how long a portion of it is above the diaphragm?

Into what does the left spermatic vein empty?

Where is the internal saphenous found in the leg? Where in the thigh?

To which side of the common femoral artery is its vein?

What forms the portal vein?

How long is the portal vein, and what is its position in the lesser omentum?

THE LYMPHATICS

Where is the thoracic duct formed?

How does it enter the thorax?

What are its relations in the thorax, and where does it empty?

Is there anything on the right side to at all correspond to the thoracic duct?

Name the places where the lymphatic nodes principally appear in groups.

PART V

NEUROLOGY, OR THE ANATOMY OF THE NERVOUS SYSTEM

THE CEREBROSPINAL AXIS

THE SPINAL CORD

THE spinal cord is enclosed by three membranes, the dura, arachnoid, and pia.

The **spinal dura** is a loose fibrous envelope which is attached closely to the margin of the foramen magnum above, but only loosely to the circumference of the vertebral canal below blending with the periosteum on the dorsum of the coccyx, where it is called the **coccygeal ligament.** Its inner surface is covered by a layer of epithelium, and it presents on each side a series of double orifices for the exits of the anterior and posterior roots of the spinal nerves. The dura is prolonged on to these nerves as a tubular investment.

The **arachnoid** is a very delicate membrane which invests the cord between the dura and pia. It is continuous above with the cerebral arachnoid, and is connected by meshes of fibrous tissue with the pia, and to some extent also with the dura, from which it is separated by the subdural space. The subarachnoid space contains the subarachnoid fluid, which separates it from the pia mater. This space, by means of the foramen of Magendie, is continuous with the cavity of the ventricles of the brain.

The **pia** is closely connected to the cord, and sends a prolongation down into the anterior, and a very delicate process into the posterior median fissure. It ensheathes the spinal nerves, and ends below in the filum terminale, which joins the dura at the upper limit of the sacral canal.

Along the anterior median surface of the pia runs a prominent fibrous band, the *linea splendens,* and between the two nerve roots on each side is a serrated band, the *ligamentum denticulatum,* the points of the serrations, about twenty on each side, being attached to the dura between the pairs of nerve roots.

The **spinal cord** is about 18 to 20 inches long, weighs about an ounce, and occupies about the upper two-thirds of the spinal canal, viz., from the foramen magnum to the lower border of the first lumbar vertebra. It ends in a narrow cord of gray substance which runs in the midst of the filum terminale.

The **enlargements of the spinal cord** are two—an *upper* or *cervical,* extending from the third cervical to the first or second thoracic vertebra, and a *lower* or *lumbar,* from the tenth thoracic to about the first lumbar. These enlargements correspond to the origin of the nerves which supply the upper and lower extremities respectively. The surface of the cord presents several *fissures,* which will now be described.

The **fissures of the spinal cord** are an anterior and a posterior median, and laterally on each side are several grooves called fissures.

The *anterior median* fissure extends through about one-third the thickness of the cord, as far as the anterior white commissure, and contains a fold of the pia.

The *posterior median* fissure extends about halfway through its substance to reach the posterior or gray commissure. It is not a real fissure, being filled up by connective tissue.

The anterolateral fissure is merely the line of origin of the anterior nerve roots, while the posterolateral is in reality a groove, and runs along the line of origin of the posterior nerve roots.

Lastly, a *slight groove,* the posterior paramedian fissure, marks off the *posterior intermediate column* on either side of the posterior median fissure.

The **columns of the spinal cord** are divisions made by these fissures, three on each side.

The **anterolateral column,** between the anterior median and posterolateral fissures. The *posterior* column, between the posterolateral and posterior median fissures, becomes divided, by the slight groove above mentioned, into the *posterior lateral* and *posterior median* columns.

The columns of the spinal cord are divided into three chief columns or funiculi: the **ventral, dorsal,** and **lateral.**

The **ventral** is subdivided into the following tracts: Descending—direct pyramidal tract, sulcomarginal tract, ventral vestibulospinal tract (Löwenthal's; anterior cerebellospinal tract); associating—association axones between spinal centres and several cranial nerve nuclei, fasciculus ventralis proprius.

Location of the tracts as regards their distribution within the cord: the direct pyramidal tract extends through the cervical and lower portion of the thoracic, and rarely as low as the lumbar region of the cord; the sulcomarginal tract is found chiefly in the cervical portion of the cord; the ventral vestibulospinal fibers terminate about the ventral horn cells, and have been traced as low as the sacral region.

The **dorsal column** is subdivided into the following tracts: Ascending—fasciculus gracilis, or tract of Goll, the fasciculus cuneatus, or tract of Burdach; descending—the comma tract of Schultze, the median oval tract of Flechsig; associating—the fasciculus dorsalis proprius, dorsal cornucommissural tract, septomarginal tract of Bruce, the fasciculus marginalis of Spitzka and Lissauer, the latter is usually described as belonging to the lateral column, but functionally it is more intimately related to the sensor neurone system of the dorsal column.

The **lateral** column is subdivided into the following tracts: Ascending—dorsolateral spinocerebellar tract of Flechsig, superficial ventrolateral spinocerebellar tract of Gowers, spinothalamic tract, spinomesencephalic tract; descending—crossed pyramidal tract, rubrospinal tract, cerebrospinal tract (Marchi and Löwenthal), lateral vestibulospinal tract, olivospinal tract of Helwig; associating—fasciculus lateralis proprius.

The **posterior cornu** is constricted at its base (*cervix cornu*), and then expands (*caput cornu*) before narrowing to its extremity (*apex cornu*). Around the latter the neuroglia forms the *substantia gelatinosa.*

The gray matter of the cord consists of nerve fibers, nerve cells, and connective tissue (*neuroglia*). The nerve cells are for the most part arranged in columns. Of these columns, one, at the inner side of the cervix cornu, is called the posterior vesicular column of Lockhart Clarke; a second, at the concavity of the gray matter, the tractus intermediolateralis; and a third is found along the anterior part of the anterior cornu.

THE BRAIN (ENCEPHALON)

The encephalon, or brain, is that part of the cerebrospinal axis which, with its membranes, is contained in the cranium. It is composed of the cerebrum, cerebellum, pons Varolii, and medulla oblongata.

The **membranes of the brain** are the dura, the pia, and the arachnoid.

The **dura** is similar in structure to the dura of the cord, but differs from it in being closely attached to the cranial bones, forming, in fact, their inner periosteum. It is continuous with that of the cord at the foramen magnum, and with the external periosteum of the cranial bones by means of its prolongations into the many foramina. It sends in various processes to support and separate the different parts of the brain, and its layers separate to form the cranial sinuses. In the vicinity of the superior longitudinal sinus are to be found, on its outer surface, several glandulæ Pacchionii. They may also be seen on its inner surface and within the sinus, as well as on the pia mater.

The processes include the falces cerebri et cerebelli and the tentorium cerebelli.

The *falx cerebri* separates the cerebral hemispheres. In front it is narrow, becoming broader behind. Its upper convex margin is attached to the vault of the cranium from the crista galli in front to the internal occipital protuberance behind. Its lower margin is free and concave anteriorly, while it is attached posteriorly to the upper surface of the tentorium. Above it lodges the superior, below the inferior longitudinal sinus and part of the straight sinus.

The *falx cerebelli* is triangular, and separates, inferiorly, the lateral cerebellar lobes. It is attached above to the under and posterior part of the tentorium, behind to the internal occipital crest, below the torcular Herophili, and to the foramen magnum, where it often divides into two parts, which are attached to its margins.

The *tentorium* covers the upper surface of the cerebellum. Its posterior border, where it is attached to the transverse ridges of the occipital bone, encloses the lateral sinuses; along the superior border of the petrous portion it forms the superior petrosal sinus, and at the junction of its upper surface with the falx cerebri is the straight sinus. Besides these points, it is attached to the anterior and posterior clinoid processes. Its anterior concave edge is free, and with the dorsum sellæ forms a large oval opening. This is called the incisura tentorii and transmits the mesencephalon.

The **pia** is a very vascular delicate membrane which dips into the sulci and forms the various choroid plexuses and also the velum of the third ventricle. The vessels of the brain run in the pia mater before entering the brain.

The **arachnoid** is a similar membrane to that of the cord, and is separated, as in the cord, by the subarachnoid fluid from the pia. It does not dip into the sulci. In front it leaves a space between it and the pia mater, viz., along the pons and interpeduncular region, the anterior subarachnoidean space; and behind, between the medulla and the cerebellum, is a second interval called the posterior subarachnoidean space. Both are connected with the ventricles of the brain by the foramen of Magendie in the pia mater covering the fourth ventricle.

The subarachnoid fluid is a clear alkaline fluid containing 1.5 per cent. of solids, animal and mineral.

Parts Derived from the Hind-brain (Rhombencephalon)

The **hind-brain** and the parts included therein—the **medulla oblongata**, the **pons**, and the **cerebellum.**

The Medulla Oblongata

The **medulla oblongata** is a pyramidal body, $\frac{3}{5}$ to 1 inch long, along its ventral surface, and $\frac{3}{5}$ inch thick. Its larger extremity is continuous with the pons; its smaller extremity, directed downward and backward, blends with the spinal cord. The anterior surface lies on the basilar groove of the occipital bone.

In front and behind it is marked by the continuation of the anterior and posterior median fissures of the cord, the former, with its process of pia mater, ending in a cul-de-sac just below the pons, the foramen cecum. The posterior expands into the fourth ventricle.

Each lateral half of the medulla is divided into areas.

The **areas of the medulla oblongata** are: (1) Ventral area; containing the pyramid. (2) Lateral area; containing the lateral tract olive. (3) Dorsal area; containing the funiculus gracilis, funiculus cuneatus, funiculus lateralis and tuberculum cinereum. (Gray.)

The restiform body succeeds the gracile and cuneate nuclei in the dorsolateral part of the medulla oblongata. Its fibers converge from various sources and ultimately enter the cerebellum as its inferior peduncle. (Gray.)

The *Decussation of the Pyramids.* It is a term applied to the interlacing bundles seen on the ventral aspect of the medulla, at the junction of the medulla and the spinal cord. Ninety per cent. of the fibers cross the median line in this decussation to continue as the crossed pyramidal tract.

Summary of the Gray Masses in the Medulla Oblongata

Central tubular gray (in "closed" part).
Gray floor of fourth ventricle (in "open" part).
Gelatinosa Rolandi, or gliosa.
Nucleus funiculi gracilis.
Nucleus funiculi cuneatus.
Nucleus funiculi cuneati accessorius.
Nucleus lateralis.
Nucleus olivarius inferior.
Nucleus olivarius accessorius dorsalis.
Nucleus olivarius accessorius medialis.
Nucleus arcuatis.
Nucleus nervi hypoglossi.
Nucleus intercalatus.
Nucleus postremus.
Nucleus vagi (ala cinereæ).
Nucleus vestibularis (spinal division).

Nucleus funiculi teretis.
Nucleus ambiguus.
Nucleus tractus solitarii.
Nucleus tractus spinalis nervi trigemini.
Formatio reticularis. (Gray.)

The Pons

The pons is a white mass on the anterior aspect of the brain stem placed between the medulla oblongata and the crura cerebri. It is convex from side to side, containing mostly transverse and longitudinal fibers. The transverse fibers are collected into rounded bundles, to continue as the middle peduncles into the white substance of the corresponding cerebellar hemispheres. The middle peduncles are commissural paths consisting of axones coursing in opposite directions connecting the nuclei pontis with the cerebellum; then some axones pass into the opposite middle peduncle, forming uninterrupted commissural systems; again, a few fibers communicate with nuclei in the brain stem, notably the oculomotor, trochlear, and abducent cranial nerves.

The **basilar surface** is in relation with the basilar process of the occipital and the dorsum sellæ of the sphenoid. In a shallow central groove (**basilar groove**) is lodged the basilar artery. The large sensor and small motor root of the trigeminal nerve pierces the prelateral portion of the pons, near its anterior pontile border; the abducent nerve passes forward and upward around the posterior pontile border (prepyramidal part); the facial and acoustic nerves arise further external in the latter border.

The **pars dorsalis pontis,** or tegmental part. The dorsal surface is continuous with that of the oblongatal ventricular surface, and will be described under the description of the rhomboid fossa or the floor of the fourth ventricle.

The Summary of the Gray Masses in the Pars Dorsalis Pontis

Nucleus of abducent nerve.
Nucleus of facial nerve.

Afferent and efferent nuclei of trigeminal nerve.
Nucleus of spinal root of trigeminal nerve.
Nuclei of Acoustic Nerve.—Cochlear division: Dorsal nucleus; ventral nucleus. Vestibular division: Medial nucleus; lateral nucleus; superior nucleus.
Superior olivary nucleus.
Nucleus of trapezium.
Reticular ganglionic formation.
Nucleus incertus.
Nucleus of lateral lemniscus. (Gray.)

The Cerebellum

The **cerebellum** is the largest portion of the hind-brain. It lies in the posterior fossa of the skull, separated from the occipital lobes of the cerebrum by the tentorium cerebelli. It is behind the pons and medulla oblongata, connected with the former through the middle peduncles, and partly embracing the latter; and connected with the restiform body by means of the inferior peduncles; the superior peduncles contain fibers which pass from the cerebellum to the tegmentum of the mid-brain, ventrad of the inferior corpora quadrigemina, the latter bundle of fibers pass to the red nucleus of the opposite side, some continue to enter the thalamus.

The cerebellum is divided into a medial segment, the **vermis,** or **worm**; two **lateral hemispheres**; a **ventral** and **dorsal notch**; and a superior and inferior surface; and is subdivided into lobes and fissures.

The **lobes** and **fissures** seen on the superior surface of the vermis or prevermis are from before backward, alternately; lingula, precentral fissure; lobulus centralis, postcentral fissure; culmen monticuli, preclival fissure; clivus monticuli, post-clival fissure; folium cacuminis, peduncular fissure. Inferior surface of vermis; tuber vermis, postpyramidal fissure; pyramis, prepyramidal fissure; uvula, postnodular fissure; nodulus. The **hemispheres** present on their superior and inferior surfaces the same fissures as mentioned under the vermis. The lobes are, the **superior surface** from before backward; the vincula lingulæ, ala lobuli centralis, anterior crescentic, posterior crescentic, superior semilunar; **inferior surface,** inferior semilunar and gracile lobes are lateral prolongations of the tuber vermis;

the postgracile fissure separates the former two lobes, which are called sometimes the posterior inferior lobules; they comprise at least two-thirds of the inferior surface of the cerebellum. The biventral, tonsilla (amygdala), and flocculus lobes are found on the inferior surface of the cerebellar hemispheres.

The **ventral notch** is in relation with the brain stem (tegmental part of the pons and corpora quadrigemina); the **dorsal notch** is smaller and narrower and lodges the falx cerebelli, which separates the hemispheres as they project beyond the inferior vermis.

The arbor vitæ is the name given to the arrangement of the white substance of the cerebellum, seen on a median section. The cerebellum weighs 5.8 ounces in the male, and 5.4 ounces in the female. The proportion between the cerebellum and cerebrum is 1 to 7.5 in the adult; 1 to 8.5 among eminent men; 1 to 20 in the newborn. (Gray.)

Summary of the Gray Masses in the Cerebellum

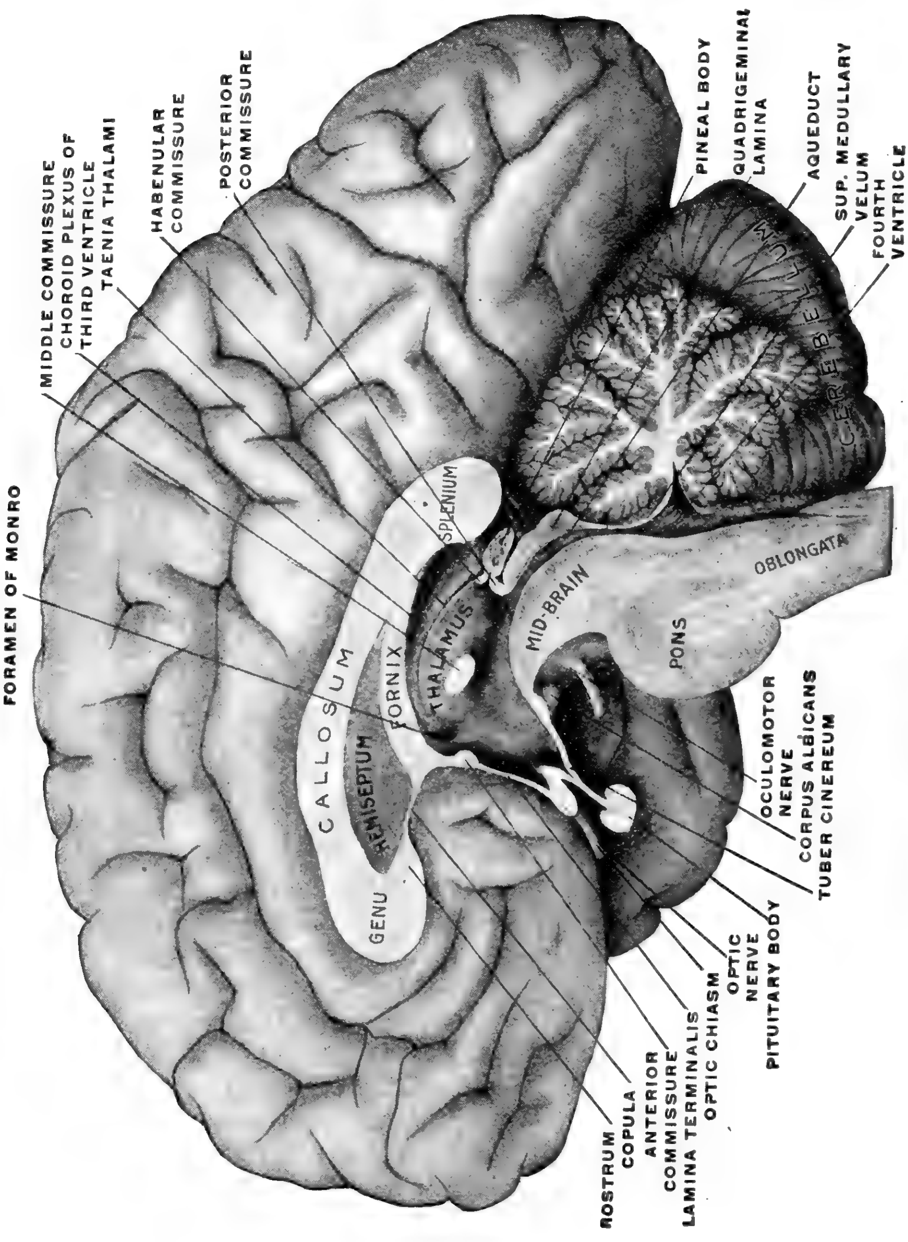
Embedded in the white substance are the following—four on each side:

Dentate nucleus or dentatum.
Nucleus emboliformis or embolus.
Nucleus globosus or globulus.
Nucleus fastigi or fastigium. (Gray.)

The Fourth Ventricle

The **fourth** ventricle (or fossa rhomboidea) is an irregularly pyramidal shaped cavity, with a lozenge-shaped base and ridge-like apex; found between the medulla oblongata and the pars dorsalis pontis in front and the cerebellum behind. It is divided into a roof and a floor. The **roof** is formed by the **valvula** (of Vieussens), the **superior peduncles, tela choroidea, ventricula quarti,** and **fastigium of the cerebellum.** The **floor** is divided into a larger cephalic (pars superior), and a smaller caudal (pars inferior) triangle by white, transverse striæ, the **striæ acusticæ,** termed the **pars intermedia** by His. The **pars superior** is separated into two halves by a longitudinal groove, the **fovea mediana.** On each side of the fovea mediana, from above downward, are the areas of the nuclei incerti and the **eminentia abducentis et facialis**; below and external to the eminentia abducentis is a depression, the **fovea superior**;

Fig. 50



Mesal aspect of a brain sectioned in the median sagittal plane.

above and external to the latter and the eminentia abducentis is the **fovea** and **area trigemini**; the **area vestibularis** is the smooth surfaces above and below the striæ acusticæ and laterad of the lateral furrow, connecting the superior and inferior fovea. The **pars inferior** presents in the centre a longitudinal furrow dividing it into two small triangles, with their bases placed cephalad. They present just adjacent to the furrow and below the striæ acusticæ the **eminentia hypoglossi** and the nucleus **intercalatus**; external to and below the latter is a depression, the **fovea inferior**, and below the fovea inferior is an eminence, the **trigonum vagi**, or **ala cinerea**, which is separated from the area postrema, by the **funiculus separans**. The convergence of the median and lateral furrows at the caudal apex of the rhomboidal fossa forms the **calamus scriptorius**, which resembles an ancient writing reed or quill pen (Gray); hence the name. Caudad the fourth ventricle is continuous with the small central canal of the cord and post-oblongata (in part); cephalad it communicates with the third ventricle by means of the aqueduct, or mesocele. The fourth ventricle has an opening through the tela choroidea, which permits of communication with the subarachnoid space, and it is called the **foramen of Majendie**; also, the extremities of the lateral recesses permit of a tidal flow of the cerebrospinal fluid, through the **foramina of Luschka**. The **locus cæruleus** is continued upward from the superior fovea and extends well up into the aqueduct; it owes its color to the refraction of the pigmented cells, the **substantia ferruginea.**

Parts Derived from the Mid-brain (Mesencephalon)

The **mid-brain** and the parts included therein—the **crura cerebri, corpora quadrigemina,** the **internal geniculate bodies,** and the **aqueduct** (mesocele) and central aqueduct gray.

The **crura cerebri** are seen, after separating the temporal lobes, as two white bundles, which emerge above the pons; diverging, they pass forward and outward to the inner and under part of each hemisphere; beneath the optic tract. Between them is seen the **intercrural** (**interpeduncular** or **posterior perforated space**); near the inner border of each crura are the roots of the motor oculi nerves passing forward from the **sulcus oculomotorius.**

The **corpora quadrigemina** are seen on the dorsal surface of the mid-brain, after the greater portion of the cerebral hemispheres and other overlying structures have been removed. They are four rounded eminences, placed in pairs, demarcated by a crucial depression. The cephalic pair, the **superior quadrigeminal bodies** (pregemina or superior colliculi), are the larger, and the **pineal body** lies between them. They are oval, and of a yellowish-gray color. The superior quadrigemina bodies, pass lateroventrad to end in the **prebrachium,** the latter being continuous cephaloventrad between the overhanging pulvinar, and the internal geniculate body. The **inferior corpora quadrigeminal bodies** (postgemina or inferior colliculi) are lighter in color than the former and passes lateroventrad to end in the **postbrachium,** the latter continuing upward and forward to pass beneath the internal geniculate body.

The *internal* **geniculate body,** or **postgeniculum,** is a small oval eminence of the lateral surface of the mid-brain in which the internal fibers of the optic tract appear to terminate. The inferior brachium or postbrachium runs into this body. It is supposed to be a way station for auditory impulses in their course to the cerebrum, also being the origin and terminus of the **arched commissure of Gudden.**

The **aqueduct** and **central aqueduct gray** are best seen on a (microscopic) cross-section of the mid-brain through the level of the superior quadrigeminal bodies. The aqueduct is a narrow canal connecting the third with the fourth ventricle. It demarcates the lamina quadrigemina dorsad from the tegmental zone, and is surrounded by the central aqueduct gray, which contains the nuclei of origin of the oculomotor, trochlear, and the mesencephalic root of the trigeminal nerves.

Summary of the Gray Masses in the Mid-brain

Central aqueduct gray: (*a*) Oculomotor nerve nucleus. (*b*) Trochlear nerve nucleus.

Nucleus radicis descendentis nervi trigemini.

Nucleus of medial longitudinal bundle and postcommissure.

Formatio reticularis.

Substantio nigra (intercalatum).

Red nucleus (rubrum).

Stratum cinereum of superior corpora quadrigemina.
Nucleus of inferior corpora quadrigemina.
Interpeduncular nucleus. (Gray.)

Parts Derived from the Fore-brain (Prosencephalon)

The **prosencephalon** is subdivided into the **diencephalon,** or **thalamic portion,** and the **telencephalon.**

The parts found under a description of the diencephalon include the **thalamus,** the **pineal body** or **epiphysis,** the **external geniculate body** and **ganglion habenulæ** the **posterior commissure,** the **pars mammillaris hypothalami,** the **corpora albicantia** and **posterior perforated space.**

The **thalami** (optic thalami) are two ovoid ganglionic masses; consisting externally of white and internally of gray. They are best seen after the removal of the overlying structures—the corpus callosum, the fornix, and velum interpositum—and rest upon (ventral surface) the tegmentum of the crura; and the central gray substance of the third ventricle.

The mesial surfaces have between them the third ventricle; the **middle commissure** fuses each with the other in 90 per cent. of the cases; these surfaces are covered by ependyma. Its dorsal limit is marked by an ependymal ridge the **tænia thalami,** fortified by a subjacent narrow band of fibers called the **stria medullaris,** which may be traced to the **habenular nucleus** and **habenular commissure** (of the pineal body). Caudad is a depression triangular area—the **trigonum habenulæ,** situated cephalad of the superior corpora quadrigeminal body. The dorsal surface (a portion) is in relation with the reflection of the ependyma of the lateral ventricle before it enters into the formation of the plexus of the lateral ventricle; the **velum interpositum** is in relation with the rest of this surface not lined by ependyma. This surface is of a faint, whitish color due to a thin layer of white fibers, the **stratum zonule.** The **tænia semicircularis** is seen laterally separating this surface from the caudate nucleus. Three eminences are seen—the tuberculum anterius, medialis, and lateralis. The anterius is bulged and forms the boundary of the **foramen of Monro,** the aperture of communication between the lateral and third ventricles. The caudal extremity is rounded and overhangs the brachia of the corpora quadrigemina and is called the

pulvinar. The lateral surface is in contact with the internal capsule.

The Connections of the Thalamus.—The thalamus is a ganglion interposed between the sensor tracts in the tegmentum and the cerebral cortex as well as an important link in the optic radiation path. Also motor tracts concerned with instinctive movements of an emotional nature. It is a relay station for the various tracts which convey sensations of touch, temperature, and pain from the body, extremities, head and neck, of muscle sense, and of the special senses. It transmits these to and receives in turn impulses from the cerebral cortex. As an "emotional" centre it is also under the inhibitory influence of the cerebral cortex, which, if the emotion be not too strong, prevents its external manifestation. (Gray.)

The **pineal body** is small, reddish-gray in color, found between the caudal ends of the thalami, and occupying the depression between the two superior corpora quadrigeminal bodies. Above is the **velum interpositum,** which intervenes between it and the splenium of the corpus callosum. Its attached base is a hollow peduncle divided into a **ventral** and **dorsal stalk** by the intrusion of the **epiphyseal recess** of the third ventricle. The **dorsal stalk** continues on either side and upon both thalami as the stria medullaris; it is also reinforced by fibers joining the habenulæ of the two sides; it is sometimes called the **habenular commissure.** The **ventral stalk** is folded over the posterior commissure.

The **external geniculate body,** or **pregeniculum,** are found on the inferior and external aspect of the thalamus and its posterior extremity—the pulvinar. They contain fibers which are received in front from the outer division of the optic tract, and behind connect with the superior quadrigeminal bodies through the prebrachium; other fibers end in the thalamus.

(Note.—The external and internal geniculate bodies are generally included under the head of metathalamus.)

The **nidus,** or **ganglion habenulæ,** is placed in the depression (the **trigonum habenulæ**) between the pineal body and the caudal end of the thalamus. They are in relation with each other through the habenular commissure, which is connected with the dorsal stalk of the pineal body.

The **posterior commissure** is a white band of fibers crossing from side to side in the ventral stalk of the pineal body, bridging the aqueduct at its continuation into the third ventricle. It contains decussating and connecting fibers (1) for the **median longitudinal bundle**; (2) the two **thalami**; (3) the **habenula nidi**; and (4) the **superior quadrigeminal bodies.**

(Note.—The habenulæ, pineal body, and posterior commissure are generally included under the head of epithalamus.)

The **hypothalamic tegmental substance** is continuous with the mid-brain tegmentum. It is found between the ventral face of the thalamus, the red nucleus, and a continuation of the substantia nigra known as the **corpus hypothalamicus**, or **body of Luys.** The fibers contained within the hypothalamic tegmentum communicate with the **medial lemniscus**, of the **superior peduncle** of the cerebellum, and from the **red nucleus** to end in relation with the thalamic cells. The corpus hypothalamicus lies frontad to the lateral part of the substantia nigra, and, like it, is situated between pes and tegmentum. Its fibers decussate in the floor of the third ventricle with those of the opposite side, dorsocaudad of the corpora albicantia.

The **corpora albicantia** are two bodies placed side by side in the intercrural space, cephalad of the posterior perforated substance, at a point where the floor of the third ventricle becomes decreased in thickness to form the tuber cinereum. They are white in color, due to a superficial layer of fibers derived from the fornix. The fibers of the fornix terminate in the corpora albicantia.

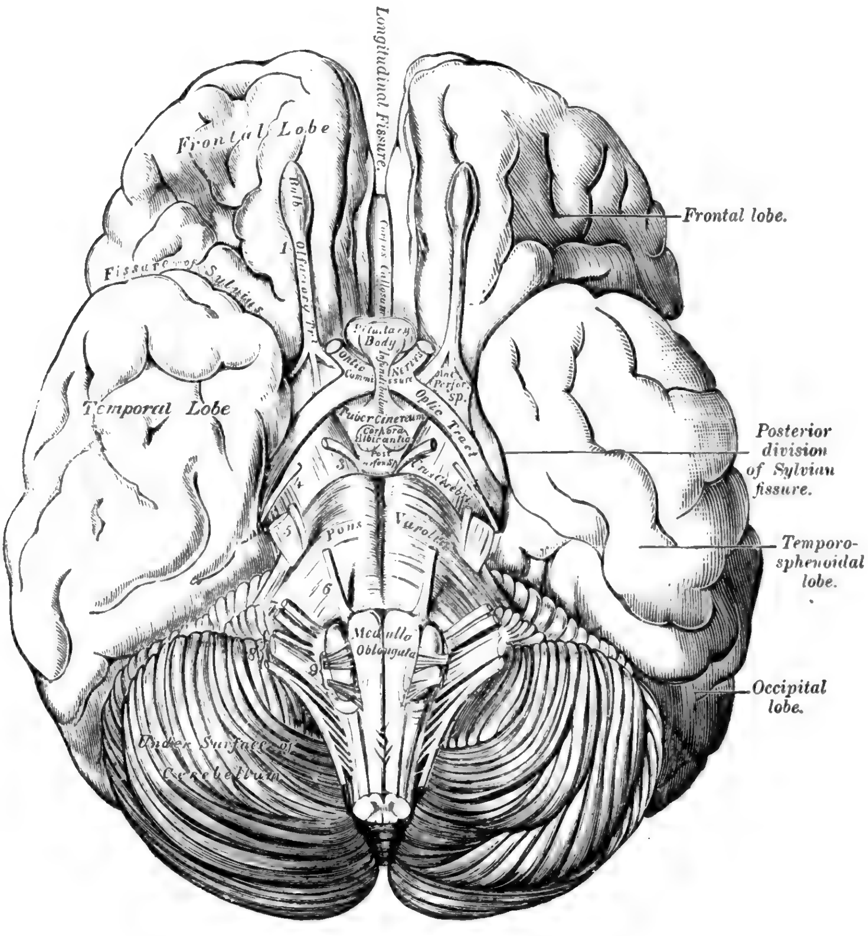
The **posterior perforated substance** marks the situation of the **interpeduncular ganglion.** From it arise the fiber tracts called the **tænia pontis.** It occupies the interval between the copora albicantia, the pons, and the crura cerebri.

(Note.—The corpora albicantia and the posterior perforated substance are generally included under the head of the Pars Mammillaris Hypothalami.)

The parts found under a description of the **telencephalon** include the **pars opticus hypothalami**, consisting of the **tuber cinereum**, the **pituitary body**, or **hypophysis**, the **infundibulum**, the **lamina terminalis**, the **optic chiasm**, and the optic tract.

The **tuber cinereum** is an elevation of gray matter between the optic tracts and the corpora albicantia, and forms part of the floor of the third ventricle. Its apical portion is attenuated, and forms the stalk of the pituitary body; the latter is called the **infundibulum;** it is hollow, and its funnel-shaped diverticulum is called the **infundibular recess of the third ventricle.** The gray lamina composing the tuber communicates with the central ventricular gray, and, therefore, with the **lamina cinerea,** or **terminalis.**

Fig. 51



Base of the brain. (Gray.)

The **pituitary body,** or **hypophysis,** occupies the **fossa hypophyseos** of the sphenoid. It is composed of a prehypophyseal and posthypophyseal portion. The former is developed from the buccal cavity; the latter of a neural origin, develop-ing as a ventral diverticulum from the primitive neural tube. The prehypophysis is the larger.

The **lamina cinerea,** or **terminalis,** is a thin, easily torn lamina between the optic chiasm and anterior commissure, bounded laterally by the cerebral hemispheres.

Optic tract (see Optic Nerve).

Optic chasm (see Optic Nerve).

The Third Ventricle

The third ventricle is derived from the primitive fore-brain vesicle, except that portion which also enters into the formation of the lateral ventricles. It is a narrow space between the two thalami and hypothalamic gray, limited in front by the terma, behind continuous with the aqueduct (Sylvian), and laterally is continuous with the lateral ventricles through the **foramen of Monro.** The **roof** is covered by an ependymal layer, fused with the tænia thalami, and the ependymal layer is reinforced by a vascular fold of pia mater, the two together constituting the velum interpositum; also the fornix. The **floor** is formed by the tuber cinereum, corpora albicantia, and posterior perforated substance, as well as the optic chiasm and a portion of the tegmentum of the crura cerebri.

In its cavity are three commissures: the *anterior,* in front of the anterior pillars of the fornix, piercing on each side the corpus striatum; the *middle,* or soft, of gray matter, connecting the thalami; and the *posterior,* also connecting the optic thalami behind, and lying in front of and beneath the *pineal gland.*

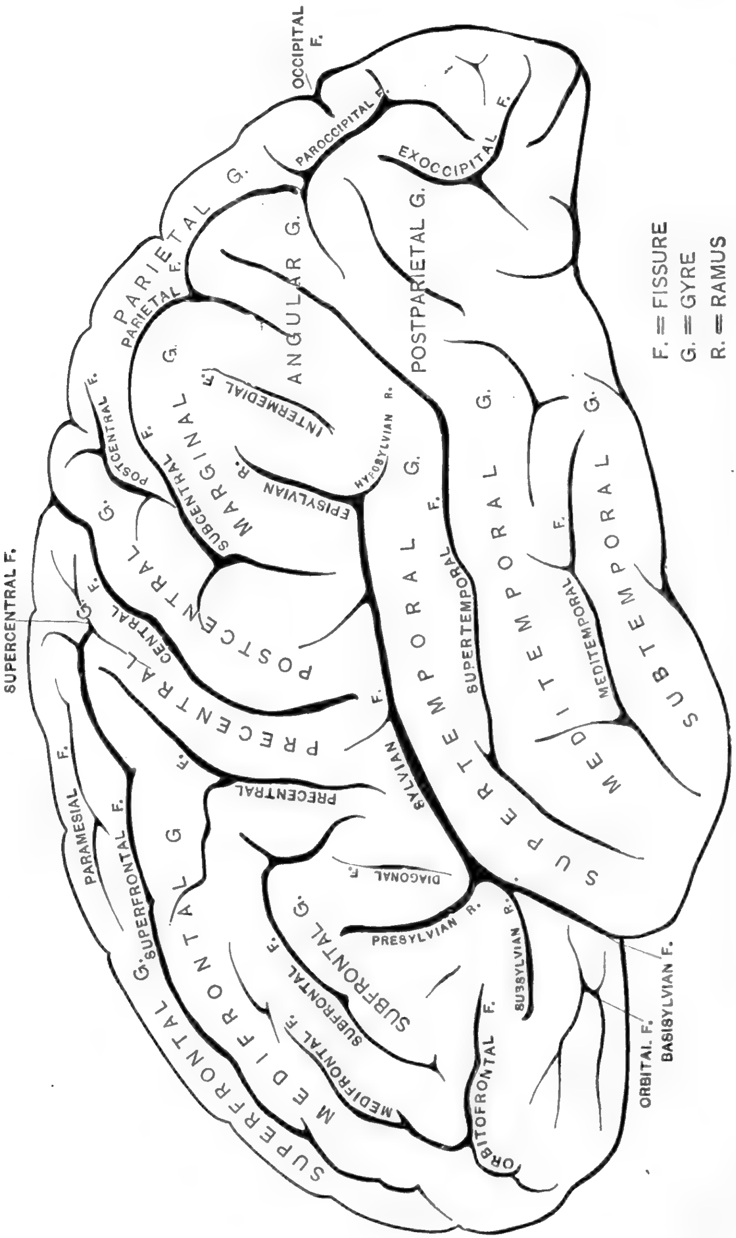
In front are the two openings, one on each side, of the foramen of Monro.

The Cerebrum

The cerebrum is the largest part of the brain, and consists of two lateral halves, or hemispheres, separated by the great longitudinal fissure and connected to each other by a great commissure, the **corpus callosum.** The latter constitutes a great system of association fibers for the bilateral coördination of corresponding cortical parts. The hemispheres are subdivided into lobes, and the latter present over their entire surfaces convoluted eminences, the **gyres,** or **convolutions,** separated by depressions, the **sulci** or **fissures.**

The cerebrum, as a whole, is convex from before backward and from side to side, narrower in front than behind. Its

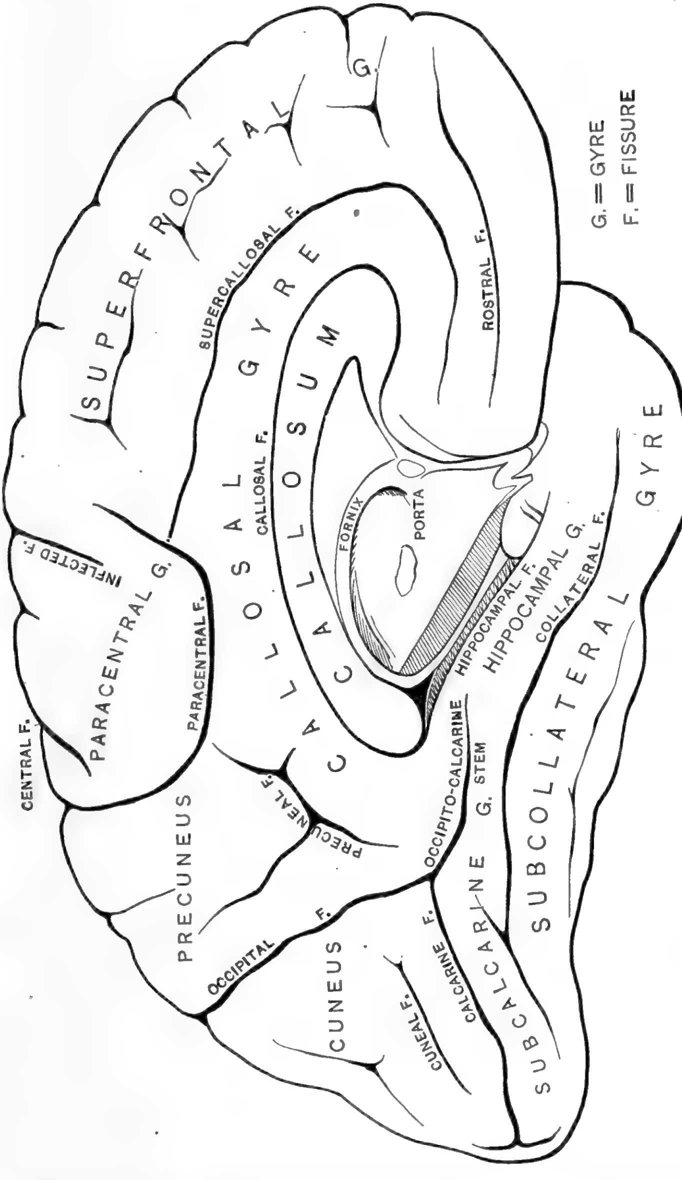
Fig. 52



Fissures and gyres of the lateral surface of the left hemicerebrum. (Gray.)

inferior surface is flattened and overlaps the mid-brain and cerebellum, from which it is separated by the tentorium cere-

FIG. 53

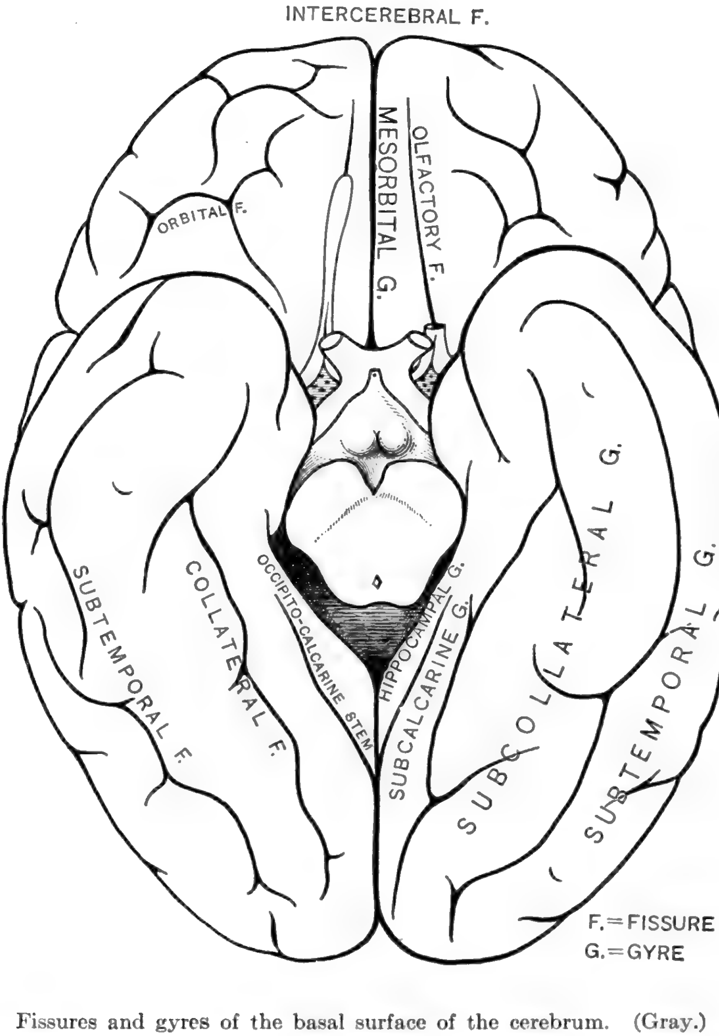


Fissures and gyres of the mesal surface of the left hemicerebrum. (Gray.)

belli. The outer surface, the cortical substance, including the gyri, is composed of gray, while the interior is of white.

The lobes are the **frontal,** the **parietal,** the **occipital,** the **temporal** and the **central lobe,** or **island of Reil.**

Fig. 54



Fissures and gyres of the basal surface of the cerebrum. (Gray.)

The **frontal lobe,** the lateral surface, is separated behind, from the parietal lobe, by the central fissure or the fissure of Rolando, and below, from the temporal lobe by the Sylvian fissure, in part, and rests on the orbital plate of the frontal bone. The **gyres** are the **precentral, superfrontal, medifrontal,** and **subfrontal.** The **fissures** are the **precentral, superfrontal,** and **subfrontal.** The **orbital surface** of the **frontal lobe** is marked by the **olfactory** fissure, which lodges the olfactory bulb and tract, and separates the **mesorbital gyre** from the **preorbital** and **postorbital gyre fields.** The latter are subdivided by the **transorbital fissure.** Sometimes the postorbital limbus may be seen on this surface. It consists of a curved, welt-shaped eminence demarcated by an incisure created by the lesser wing of the sphenoid, and due, apparently, to the intrusion of the postorbital portion into the middle fossa of the skull. (Gray.)

The **mesal surface** of the frontal lobe presents the **paracentral gyre,** limited by the caudal and cephalic limbs of the **paracentral fissure**; the superfrontal and callosal gyre, separated by the **supercallosal fissure** and the rostral fissure is found in the inferior region of this surface.

The **parietal lobe,** lateral surface, is bounded in front by the central fissure, below by the Sylvian fissure, above by the dorsimesal border; it is only partially separated from the occipital lobe by the occipital fissure, merging gradually into the temporal lobe. The gyres are the **postcentral,** the **parietal,** the **subparietal** the **marginal,** the **angular,** the **postparietal;** the paraoccipital is the gyre connecting the parietal and occipital gyres. The marginal connects the postcentral and supertemporal gyres; the angular connects the supertemporal and meditemporal gyres. The **fissures** are the **postcentral,** the **subcentral,** the **parietal;** the **paraoccipital** (anterior portion). The less constant fissures are the **transparietal** and the intermediate fissures. In the subparietal region terminate the upturned ends of the Sylvian (*i. e.,* episylvian ramus), and the supertemporal and meditemporal fissures.

The **mesal surface** of the parietal lobe. The **precuneus** gyre is found, separated in front and above from the **paracentral** gyre by the **paracentral** fissure, below and above, from the **cuneus** by the **occipital** fissure; while below and in front it is demarcated from the **callosal** gyre by the **precuneal** fissure.

The **occipital lobe, the lateral surface** is bounded anteriorly by the **occipital** fissure, which partially separates it from the parietal lobe, also the **paraoccipital** and **exoccipital** fissures are seen extending into the lobe.

The **mesal surface** presents the **cuneus** embraced by the **occipital** and calcarine fissures; a small fissure is seen near the posterior third of this surface, and is called the **cuneal.**

The **temporal lobe,** the **lateral surface** is bounded by the **basisylvian** and Sylvian fissures and by the ventrolateral border; posteriorly, it merges into the adjacent parietal and occipital lobes. The **gyre** are the **supertemporal,** the **meditemporal,** and **subtemporal.** The **fissures** are the supertemporal and meditemporal.

The **tentorial** or **ventral surface** of the temporal lobe: The gyre are the **subcalcarine,** the **subcollateral,** and part of the **subtemporal;** near the dorsimesal part of the ventral surface is found the **hippocampal,** and the uncinate gyre is found toward the temporal pole. The **fissures** are the **subtemporal, collateral,** and the **occipitocalcarine stem,** the **hippocampal,** and the **postrhinal.**

The **dorsal** or **opercular surface** of the temporal lobe enters into the formation of the Sylvian cleft. The **transtemporal fissures** and **transtemporal gyres** are found upon this surface.

The **island of Reil** (central lobe or insula) is seen after separating the lips of the Sylvian cleft, and is overlapped by the opercula; the latter removed, the island of Reil is seen as a tetrahedral-shaped mass with its apex directed ventrocephalad. Its borders are sharply outlined by the **circuminsular fissure,** except in the depths of the basisylvian cleft, where the insular cortex is continuous with the gray substance of the anterior perforated substance or **lumen insulæ** (belonging to the rhinencephalon). The **transinsular** or **central fissure** divides this area into a larger **preinsular** and a smaller **postinsular** part. The **preinsular** shows four to five **preinsular gyres;** the **postinsular** presents a single long gyre (the gyrus longus insulæ).

The **rhinencephalon,** or **olfactory lobe,** constitutes the central olfactory structures, as distinguished from the rest of the fore-brain (pallium). It comprises: (1) Peripheral parts; (2) central or cortical portions; the former is divided into **pre-** and **postolfactory** portions.

The Peripheral Part

Preolfactory lobe:
1. Bulbus olfactorius.
2. Tractus olfactorius.
3. Tuberculum olfactorium and trigonum.
4. Area parolfactoria (Broca).
5. Stria (gyrus) olfactorius medialis.
6. Stria (gyrus) olfactorius intermedialis.
7. Stria (gyrus) olfactorius lateralis.

Postolfactory lobe:
8. Anterior perforated substance.
9. Gyrus subcallosus and Broca's diagonal band.

The Cortical and Central Part

Cortical:
1. The hippocampus.[1]
2. The uncus.
3. Gyrus dentatus.
4. Fasciola cinerea.
5. Indusium, medial and lateral longitudinal striæ upon the corpus callosum.
6. Gyri Andreæ Retzii.
7. Gyri subcallosi.

Central:
8. Fornix and fimbria.
9. Corpus albicans and albicanothalmic tract.
10. Part of anterior commissure (precommissure).
11. Part of septum pellucidum. (Gray.)

Horizontal Sections of the Brain

Horizontal section of the hemispheres about one-half inch above the corpus callosum brings into view the white matter constituting the *centrum ovale minus.* This is dotted with the puncta vasculosa, due to the divided bloodvessels. A section at the level of the corpus callosum is called the *centrum ovale magus* of Vieussens.

[1] Not to be confounded with the hippocampal gyre of the pallium.

The anterior part of the *corpus callosum* forms in front a bend, the *genu,* and this extends back along the base of the brain up to the lamina cinerea as the *rostrum.* Here it sends off the peduncles of the corpus callosum. Behind it forms a thick border, the *splenium,* or pad. The under surface of the corpus callosum is connected behind with the fornix and for the rest of its extent with the septum lucidum. It forms the roof of the lateral ventricles.

The **corpus callosum** is a mass of transverse fibers seen on separating the hemispheres of the cerebrum. It is best studied from a view of a mesial section. The mass of radiating fibers pass transversely, connecting almost every part of one cerebral hemisphere with the corresponding part of the other. They radiate in various directions within the hemispheres, and are divided into a **pars frontalis,** a **pars parietalis,** and a **pars occipitalis.**

A portion of the dorsal surface is free for a width of about 1 cm. on either side of the mesial plane, partly covered by the indusium, and overlapped by the callosal gyres, a fold of pia intervening.

It is a long, thick, somewhat flattened arch of white, bending upon itself anteriorly to form the **genu,** while its posterior extremity is rounded and somewhat folded to form the **splenium.** The genu becomes reflected to form the **rostrum,** which ends in a flattened portion called the **cupola,** which in turn joins the lamina terminalis in front of the anterior commissure.

The Lateral Ventricles

The **lateral ventricles** are serous cavities, have a thin lining membrane, covered by a layer of epithelium cells (*ependyma*), which secrete a serous fluid. They are contained one in each hemisphere, separated by the *septum lucidum,* and each is divided into a *body* and *three cornua,* an anterior, posterior, and middle. The foramen of Monro connects them with the third ventricle.

The *central cavity,* or *body,* is roofed by the corpus callosum, and in the floor, from without inward, are found the caudate nucleus of the corpus striatum, tænia semicircularis, part of the optic thalamus, choroid plexus, and part of the fornix.

The *anterior cornu* projects into the anterior lobe and runs outward around the nucleus caudatus. Above and in front of it is the corpus callosum.

The *posterior cornu,* or digital cavity, runs back into the posterior lobe, its direction being backward, outward, and lastly inward. Its floor presents the eminence of the *hippocampus minor,* or calcar avis. At the junction of the posterior and middle cornua is the *eminentia collateralis,* or *pes accessorius.*

The *middle* or *descending cornua* curves around the back of the optic thalamus, descending at first backward and outward. It then runs downward, forward, and lastly inward. In its floor are the hippocampus major and pes hippocampi, corpus fimbriatum, and choroid plexus; the fascia dentata lies within the hippocampal or dentate fissure, and the transverse fissure runs along the inner side of the cornu.

The **fornix** is an arched longitudinal commissure of white matter below the corpus callosum, its lateral margins forming part of the floor of the body of the lateral ventricles. In front its two lateral halves are divergent, and form the *anterior pillars;* behind they diverge into the two *posterior pillars;* the central part is the *body.* The body is triangular, attached above to the corpus callosum and septum lucidum; below the velum interpositum separates it from the third ventricle and optic thalami. From under each side project the choroid plexuses.

The *anterior pillars* descend through the gray matter on the sides of the third ventricle and form the anterior boundaries of the foramen of Monro. Then they emerge at the base of the brain to form the corpora albicantia, from which each pillar turns upward and ends in the corresponding optic thalamus. In their course each communicates with the peduncle of the pineal gland and the tænia semicircularis.

The *posterior pillars* are connected with the corpus callosum, then enter the dscending cornua, and are partly prolonged into the upper surface of the hippocampus major and partly into the corpus fimbriatum.

The **foramen of Monro** is a foramen connecting each lateral ventricle with the anterior part of the third. In front it is bounded by the anterior pillar of the fornix; behind, by the anterior part of the optic thalamus; above, by the anterior extremity of the body of the fornix.

The **velum interpositum** is a process of the pia mater which occupies the great transverse fissure, and hence separates the fornix from the third ventricle. In front it sends a process through the foramen of Monro to each lateral ventricle. From its under surface it supplies the two vascular processes which form the choroid plexuses of the third ventricle, and on each side the choroid plexuses of the lateral ventricles are found.

The Third Ventricle

This is the expanded interval into which the Sylvian aqueduct opens, and which lies between the optic thalami. The *velum interpositum,* with the choroid plexuses, connected on each side with the *peduncles of the pineal gland,* forms its roof together with the posterior commissure. Its floor presents the lamina cinerea, tuber cinereum, infundibulum, corpora albicantia, posterior perforated space, and tegmentum of crura. In front it is bounded by the anterior commissure and the lamina cinerea. Behind is the opening of the aqueduct of Sylvius.

The **corpus striatum** is a mass of gray matter, and consists of an extraventricular portion embedded in the hemisphere, and called the lenticular nucleus, and an intraventricular part in the body and anterior cornu, the nucleus caudatus.

The *caudate nucleus* is pyriform, projecting into the body and anterior cornu by its broad end, and by its smaller end into the roof of the middle cornu nearly to its tip.

The *lenticular nucleus* is divided into three zones, visible on transverse vertical section. It is separated from the caudate nucleus by the *internal capsule,* and the *external capsule* separates it from the *claustrum.* This nucleus and the caudate are joined together in front, being continuous with the gray matter of the anterior perforated space.

The *claustrum* is a gray lamina marked externally by ridges and furrows corresponding to the gyres and sulci of the island of Reil.

The *nucleus amygdalæ* is a small gray mass projecting into the apex of the middle cornu, and continuous with the cortical part of the apex of the temporal lobe.

The **tænia semicircularis** lies in a groove between the caudate nucleus and the optic thalamus. In front it joins the anterior pillar of the fornix; behind it enters the nucleus amygdalæ. Beneath it is the vena corporis striati.

The **choroid plexus** is a very vascular fringe covered with epithelium continuous with that of the ependyma, and forms the border of the velum interpositum. It extends from the foramen of Monro, where it is continuous with the other, across the floor of the body of the ventricle and into the middle cornu.

The **corpus fimbriatum** is the narrow band of white matter on the hippocampus major into which is prolonged the posterior pillar of the fornix.

The **hippocampus major** is a curved white prominence in the floor of the middle horn. Its lower part presents the appearance of a paw from its grooves and eminences, hence called the *pes hippocampi.* The hippocampus major is caused by the dentate fissure, and the gray matter contained in this fissure (*dentate convolution*) projects as a free margin—the *fascia dentata.*

The **eminentia collateralis** (pes accessorius) is formed by the collateral fissure.

The **great transverse fissure of Bichat,** separating the cerebrum and cerebellum, lies between the fornix and the splenium of the corpus callosum above and the corpora quadrigemina below; laterally, it lies between the back part of the optic thalamus below and the corpus fimbriatum and fascia dentata above. It is really a cleft into the ventricle, produced by pulling out the pia forming the velum interpositum.

The **septum lucidum** separates the lateral ventricles. It is composed of two layers, a small space containing fluid being left between them called the fifth ventricle. It is attached above to the corpus callosum, below to the anterior pillars of the fornix and the reflected portion of the corpus callosum.

The Base of the Brain

On the under surface of the encephalon are found the base of the frontal, resting on the orbital plate of the frontal bone and the temporal lobe, of which there are a middle and a posterior portion; the former lying in the middle fossa of the skull and the posterior lying on the upper surface of the tentorium cerebelli.

From before backward the following parts come into view: Longitudinal fissure, corpus callosum, lamina cinerea, olfactory bulb and tract, fissure of Sylvius, anterior perforated space, optic commissure, tuber cinereum, infundibulum, pituitary body, corpora albicantia, posterior perforated space, crura cerebri, pons, medulla, and cerebellum.

The *great longitudinal fissure* completely separates the right and left hemispheres, and at the bottom of it is the corpus callosum.

The *corpus callosum* is placed nearer the front than the back of the hemispheres, being convex from before backward above, concave below; the fibers run transversely, but along the middle line is a longitudinal raphé with a white band on each side, the *mesial longitudinal striæ*, and near the margin some *lateral longitudinal striæ.*

The *lamina cinerea* is a thin layer of gray matter lying between the chiasma and the corpus callosum, and continuous with the gray matter of the anterior perforated space on each side. It forms part of the floor and anterior boundary of the third ventricle.

The *olfactory tract* runs in a groove close to the great longitudinal fissure on the under surface of the frontal, and ends in an enlargement, the bulb, from which the olfactory nerve descends through the cribriform plate. Behind, the tract divides into two roots. The outer runs back along the margin of the anterior perforated space to the Sylvian fissure; the inner to the longitudinal fissure. The triangular space between the two roots is occupied by gray matter forming part of the *tuber olfactorium,* which lies in a depression on the frontal lobe, and is composed internally of white matter.

The *fissure of Sylvius* lodges the middle cerebral artery. At its inner part is the fasciculus unciformis, connecting the frontal and temporal lobes.

The *anterior perforated space* is a triangular depression at the inner side of the Sylvian fissure, of a grayish color, and is pierced by many small vessels passing to the corpus striatum, under which it lies.

The *optic commissure,* or *chiasma* (see Optic Nerve), is formed by the union of the two *optic tracts.* It lies below the lamina cinerea and in front of the tuber cinereum.

Between the optic tracts and the crura cerebri is a diamond-shaped area, the *interpeduncular space.* This space includes the tuber cinereum, infundibulum, pituitary body, corpora albicantia, and the posterior perforated space.

The *tuber cinereum* is an elevation of gray matter between the optic tracts and corpora albicantia, and forms part of the floor of the third ventricle. From its under surface the *infundibulum* runs down to the pituitary body. The former is hollow and of a conical form, its cavity communicating with the third ventricle.

The *pituitary body,* or *hypophysis cerebri,* is a reddish-gray mass occupying the sella turcica. Its weight is from 4 to 10 grains. It consists of two lobes, the anterior and larger of which encloses the posterior. The former is of a yellowish-gray color; the latter in fetal life contains an aperture which communicates with the infundibulum.

The *corpora albicantia* are two bodies placed behind the tuber cinereum. They are composed of white matter, are about the size of a pea, and contain each a gray nucleus which is connected with its fellow across the median line. Each is formed by the corresponding anterior pillar of the fornix.

The *posterior perforated space* forms part of the posterior portion of the floor of the third ventricle, and is pierced by small vessels for the optic thalami. It occupies the interval between the corpora albicantia, the pons, and the crura cerebri.

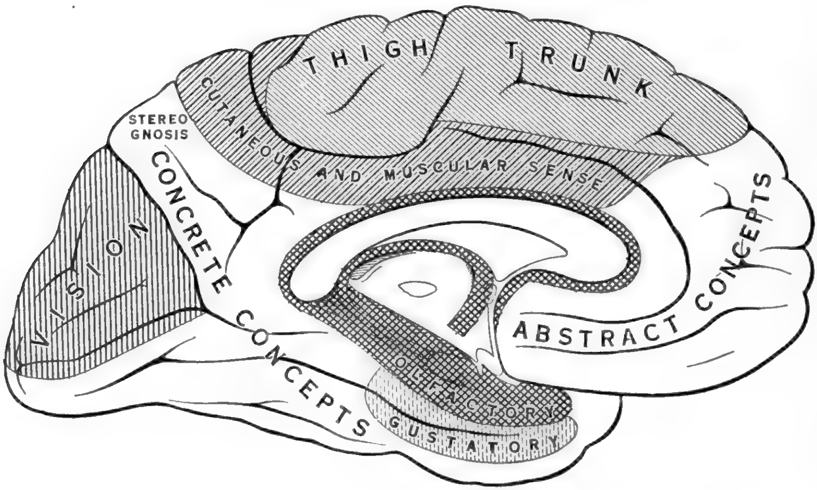
The *crura cerebri* are broader in front than behind and less than one inch in length. They run from the upper border of the pons to the hemispheres of the cerebrum, under the optic tracts, which cross them. The fourth nerve crosses the outer side, and the third issues from the inner side of each.

Each crus is composed of two parts separated by gray matter, the *locus niger.* The ventral part, or *crusta,* is a continuation of the *pyramidal fibers* from the medulla and pons, while the dorsal part, or *tegmentum,* is the continuation of the *deep longitudinal fibers* of the pons. The crustæ of the two sides are entirely separate, but the tegmenta are connected at the median line.

Cortical Localization of Function

Motor Area.—Comprises the precentral gyre and parts of the frontal gyres adjacent thereto, together with the paracentral, and the adjacent portion of the superfrontal gyre on its mesal aspect. This area comprises the centres for the muscle control of the following parts of the body located as follows:

FIG. 55



Mesal view of left cerebral hemisphere, showing localization of functions.

Lower limbs.—Dorsal part of precentral and paracentral gyres.

Trunk.—Frontad both on the mesal aspect and in the dorsal superfrontal gyre.

Upper Limb.—Midportion of precentral gyre.

Facial.—Ventral part of precentral gyre.

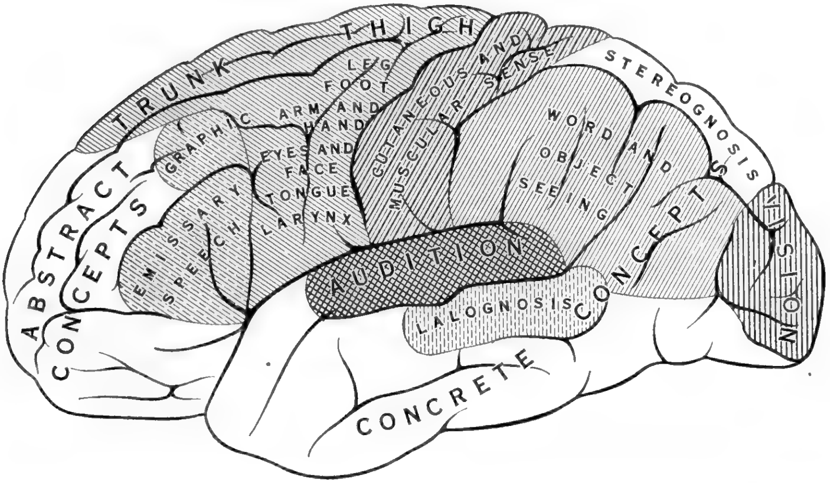
Tongue, Larynx, Muscles of Mastication, Pharynx.—Frontal opercular part.

Movements of Head and Eye.—Medifrontal gyre, adjacent to precentral gyre.

Owing to a decussation of the pyramidal (motor) tracts in their course to the primary motor centres, the motor centres in one cerebral hemisphere control the movements of the opposite side of the body.

Sensor Areas.—Tactile and temperature impressions. Postcentral gyre, in corresponding order with the neighboring precentral motor area; the postcentral (sensor) and precentral (motor) gyres are so closely associated in the highest category of the reflex arc system represented in the cerebral cortex that they are included under the term of **sernesthetic** or **sensomotor area,** devoted to the registration of cutaneous impressions, impressions from the muscles, tendons, and joints; in short, the sense of movement.

Fig. 56



Lateral view of left cerebral hemisphere, showing localization of functions. (Gray.)

Stereognostic Sense Area (concrete perception of the form and solidity of objects).—Parietal gyre, and its extension in the precuneus on the mesial aspect.

Auditory Area.—Middle third of supertemporal and adjacent transtemporal gyres in the Sylvian cleft.

Visual Area.—Calcarine fissure, and cuneus as a whole.

Olfactory Area.—Uncus, frontal part of hippocampus, indusium, subcallosal gyre, parolfactory area, and anterior perforated substance.

Gustatory Area.—Probably in region of the olfactory area in the temporal lobe (uncinate and hippocampal gyre?) (not definitely settled).

Language Areas.—Emissive (articular) centre for speech (control of muscles used in speech; larynx, tongue, jaw muscles). Junction of subfrontal gyre with the precentral gyre.

Auditory perceptive centre (word deafness) also the lalognostic (word understanding) centre.—Marginal gyre and adjacent parts of super- and meditemporal gyre.

Visual receptive centre (word blindness).—Angular gyre.

Emissive "Writing" Centre.—Medifrontal gyre, in front of motor area for the upper limb (this has not been definitely proved or accepted).

Language Arrangement Centre.—**Island of Reil** or insular association area serving to connect the various receptive sense areas relating to the understanding of the written and spoken word with the somesthetic emissary centre related to articulate speech and writing.

Association Areas.—Under this heading are included the **frontal association area** concerned, as far as is known, with the powers of thought in the abstract, creative, constructive, philosophic. The **parieto-occipito-temporal area** were concerned with the powers of conception of the concrete, for the comprehension of analogies, comparing, generalizing, and systematizing things heard, observed, and felt. (Gray.)

THE PERIPHERAL NERVOUS SYSTEM

THE CRANIAL NERVES

The cranial nerves consist of twelve pairs, as follows:

I. Olfactory (fila).
II. Optic.
III. Oculomotor.
IV. Trochlear.
V. Trigeminal.
VI. Abducent.
VII. Facial,
  Nervus intermedius.
VIII. Acoustic,
  1. Cochlearis.
  2. Vestibularis.
IX. Glossopharyngeal.
X. Vagus.
XI. Spinal accessory,
  1. Accessory to vagus.
  2. Spinal part.
XII. Hypoglossal.

These nerves have each a superficial and a deep origin. The former corresponds to its point of attachment at the surface of the brain; the latter to certain nuclei or collections of nerve cells in the structure of the brain.

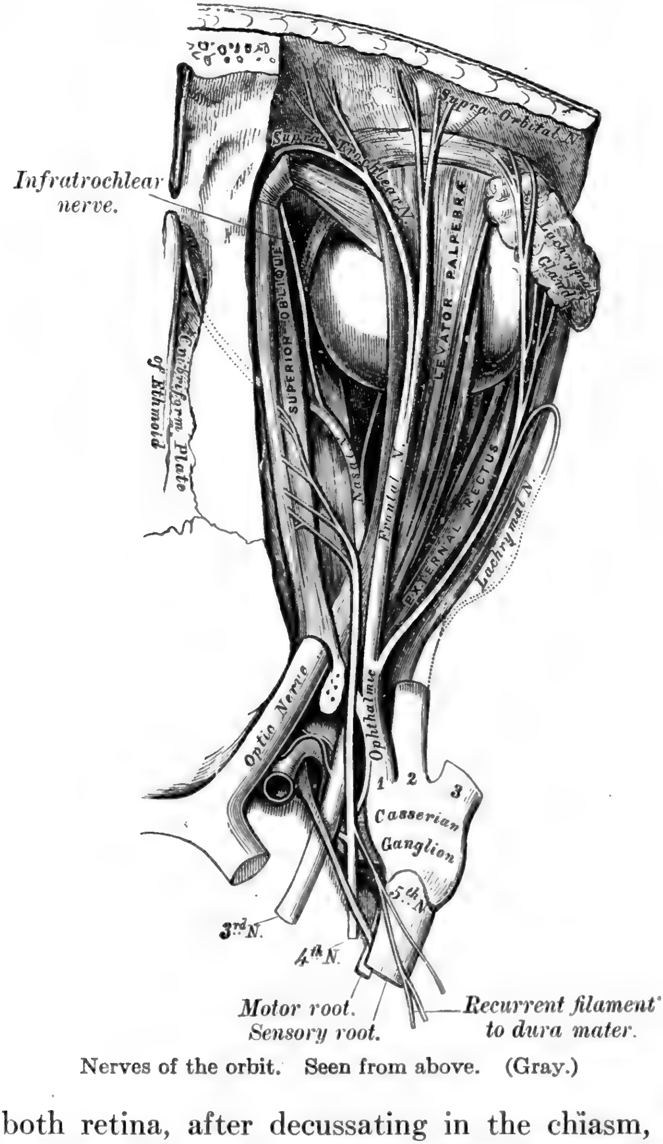
The Olfactory Nerves

The **olfactory nerves,** or **fila,** are the special nerves of the sense of smell. Twenty in number on each side. They are distributed to the olfactory region in the upper part of the superior turbinated process of the ethmoid and corresponding portion of the nasal septum. These filaments represent the axones of the olfactory cells and pass through the cribriform plate of the ethmoid to join the under surface of the **olfactory bulb,** which rests on the cribriform plate, and is the oval mass of a grayish color that forms the anterior extremity of a slender process of brain substance called the **olfactory tract.** The olfactory nerves differ in structure from the other nerves, containing only amyelinic fibers.

The Optic Nerves

The fibers of the optic nerves, the special nerves of the sense of sight, are situated in the retina; they start as the central processes of the ganglion cells, which converge and pierce the choroid and sclera as a cylindric cord. The point of emergence is situated a little internal to the posterior pole of the globe. Passing through the orbital fat, in an inward and backward direction, it passes through the optic foramen to end in the optic chiasm. The **optic chiasm** is somewhat quadrilateral in shape, rests on the olivary eminence and the diaphragma sellæ, being bounded above by the lamina terminalis; behind, by the tuber cinereum; on either side by the anterior perforated substance. Within the chiasm the fibers decussate as follows: Those from the nasal side of the left and right halves of the retina cross in the centre, to the opposite optic tract; those from the temporal side of the right and left eyes pass backward without decussating, to end in the optic tract. In the posterior portion of the chiasm is Gudden's commissure, which contains fibers, completing an arc with the medial geniculate bodies on either side. The fibers from the temporal sides of both eyes after leaving the chiasm send fibers to the pulvinar, the lateral geniculate bodies, and an inner set which pass to the superior quadrigeminal bodies. The fibers from the nasal

Fig. 57



Nerves of the orbit. Seen from above. (Gray.)

side of both retina, after decussating in the chiasm, pass to the pulvinar and lateral geniculate bodies, through an outer set of fibers, and communicate also with the superior quadrigemina bodies, by means of an inner set of fibers. The bond of union between the cuneus and the pulvinar and lateral geniculate bodies is by means of fibers, called the **optic radiation.** The latter transmit visual impulses to the cortex. The inner set of fibers in the optic tract pass to the superior quadrigeminal bodies, then to the nuclei of the third, fourth, and sixth nerves, at the same time receiving fibers from the cortical centre (corticifugal tract) contained within the optic radiation. Thus through the superior quadrigeminal bodies reflex paths pass to the eye-muscle centres and in their turn are influenced by the cortical centres through the corticifugal tract.

The Oculomotor

The oculomotor arises superficially from the crus anterior to the pons, its deep origin being a gray nucleus in the floor of the aqueduct of Sylvius. It runs to the outer side of the posterior clinoid process, enters the cavernous sinus, runs above the other nerves in its outer wall, and divides into *two branches*, which enter the orbit between the two heads of the external rectus. It is joined in the sinus by sympathetic filaments. The *superior* branch crosses the optic nerve to supply the superior rectus and levator palpebræ. The *inferior* divides into three parts—one for the inferior oblique, one to the inner, and one to the lower rectus. The first supplies the motor root of the lenticular ganglion.

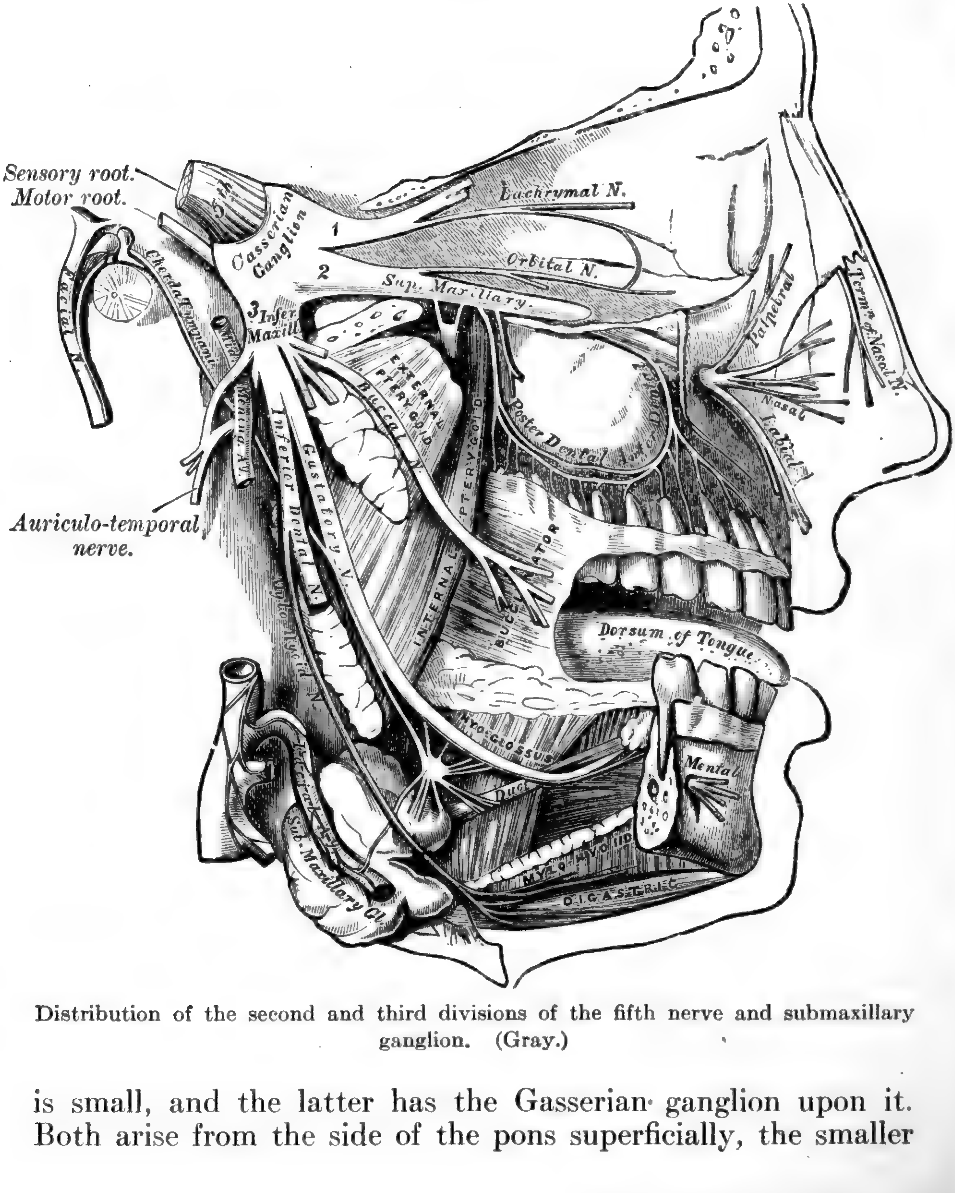
The Trochlear

The trochlear nerve has an apparent origin laterad of the frenulum veli, immediately behind the posterior quadrigeminal body, and a deep from the floor of the aqueduct of Sylvius. The two nerves communicate by a transverse band on the valve of Vieussens. The nerve pierces the dura after crossing over the crus, enters the cavernous sinus, in whose outer wall it lies between the ophthalmic and third nerves, then crosses the latter to enter the orbit through the sphenoidal fissure above the external rectus, and enters the superior oblique after crossing over the levator palpebræ. It receives sympathetic filaments in the sinus, and sends a recurrent branch into the tentorium.

The Fifth Nerve

The fifth or trifacial is the largest of all the cranial nerves, and arises by two roots, a motor and a sensor. The former

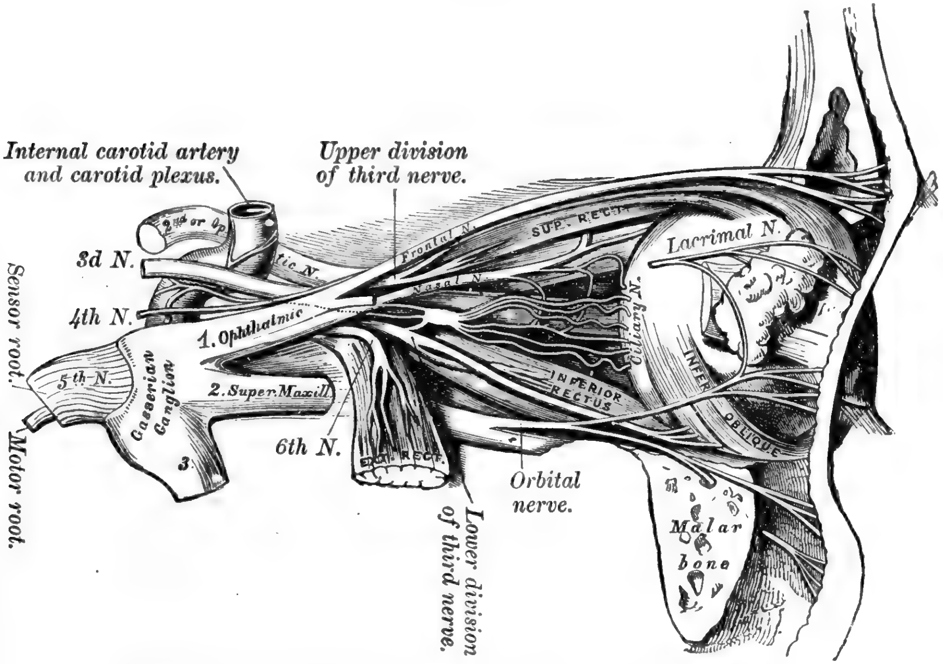
FIG. 58



Distribution of the second and third divisions of the fifth nerve and submaxillary ganglion. (Gray.)

is small, and the latter has the Gasserian ganglion upon it. Both arise from the side of the pons superficially, the smaller root above the larger, some transverse fibers of the pons separating the two. This nerve confers both motion and sensation. At the apex of the petrous portion of the temporal the large root forms the *Gasserian ganglion;* the smaller does not join in the ganglion, but runs below it to join, just below the foramen ovale, the lowest trunk proceeding from the ganglion.

Fig. 59



Nerves of the orbit and ophthalmic ganglion. Side view. (Gray.)

The **Gasserian ganglion** lies in a hollow near the apex of the petrous portion of the temporal, the large superficial petrosal nerve, and the motor root lying below it. It receives branches from the carotid plexus. Small twigs pass to the dura mater. This ganglion sends off three large branches, viz., the ophthalmic, superior maxillary, and inferior maxillary.

The first two confer sensation, the third, motion and sensation.

The **ophthalmic nerve,** or first division of the fifth nerve, is sensor, and the smallest branch of the ganglion. It is flattened, about one inch long, and runs in the outer wall of the cavernous sinus, being the lowest of the nerves. It receives *filaments from* the *cavernous plexus*, and gives off *filaments* to the *third* and *sixth*, and sometimes to the *fourth* nerve, and a *recurrent* branch running in the tentorium with the fourth. Finally, it divides into the frontal, lacrymal, and nasal nerves, which pass through the sphenoidal fissure into the orbit.

The **lacrymal,** the smallest, runs with the lacrymal artery above the external rectus muscle to the gland, which it supplies, as well as the conjunctiva, communicating with the superior maxillary nerve. It then pierces the palpebral ligament to end in the upper lid, joining branches of the facial.

The **frontal,** the largest branch, enters the orbit through the widest part of the sphenoidal fissure, just below the periosteum, and divides about the middle of the orbit into the *supratrochlear* and *supraorbital* nerves. The former runs in over the pulley of the superior oblique, and leaves the orbit between it and the supraorbital foramen. It then ascends beneath the muscles and ends in the skin of the forehead. It communicates in the orbit with the infratrochlear nerve. The frontal nerve continues as the supraorbital, which passes through the supraorbital foramen, supplies the upper lid, and divides into an inner and an outer branch. These ascend on the forehead and supply the pericranium and skin, the outer reaching nearly to the lambdoid suture.

The **nasal** enters the orbit between the two divisions of the third nerve, and between the heads of the external rectus, and then crosses over the optic nerve and runs to the anterior ethmoidal foramen. In the orbit it gives off a *branch* to the *ophthalmic ganglion*, one *long ciliary* to the eyeball, and an *infratrochlear* branch. It then reënters the cranial cavity through the anterior ethmoidal canal. In the cranium it runs in a groove on the cribriform plate, and through a slit on the side of the crista galli into the nose, where it gives off an *external* and an *internal* branch. The latter supplies the mucous membrane of the septum, and the external the outer wall of the nasal fossa. The nerve then runs in the groove on the nasal bone to end as the *anterior* branch in the integument of the tip of the nose, joining facial branches.

The **ophthalmic ganglion** is found at the back of the orbit, between the optic nerve and the external rectus. It has three roots, viz., the long or *sensor,* from the nasal branch of the ophthalmic; a short or *motor,* from the branch of the third to the inferior oblique; and the *sympathetic* root, from the cavernous plexus.

Branches.—Six or eight *short ciliary,* which run with the ciliary arteries above and below the optic nerve, and are joined by a branch from the long ciliary of the nasal. They pierce the sclerotic to supply the ciliary muscle and iris.

The **second division of the fifth nerve** (superior maxillary) is sensor and enters the foramen rotundum, crosses the sphenomaxillary fossa, and, as the **infraorbital**, traverses the canal, emerges from the foramen to end on the face in *palpebral, nasal,* and *labial* branches—the first set, to lower lid; the second, to side of nose; and the third, to upper lip. These branches join with the facial to form the infraorbital plexus. The superior maxillary nerve also gives off *two branches* to *Meckel's ganglion,* an *orbital* and *alveolar* branch, and a *recurrent* branch to the dura mater.

The **orbital** or temporomalar branch enters the orbit by the sphenomaxillary fissure, and divides into two branches, which pierce the malar bone. The *malar* branch supplies the skin of the cheek, and joins the facial. The *temporal* branch, after piercing the malar bone, enters the temporal fossa, and ends in the skin over the forepart of the temporal region, joining the facial and auriculotemporal nerves.

The **alveolar** or superior dental nerves are three: The *posterior* divides into two, which run on the zygomatic surface of the superior maxilla, supplying the gum and the mucous membrane of the cheek, and enter the posterior dental canals to the molar teeth. The *middle* runs to the bicuspids along a canal in the antrum. The *anterior* descends in its canal, and gives a *nasal* branch to the pituitary membrane, and *dental* branches to the canine and incisor teeth.

Meckel's ganglion is also called the sphenopalatine, and lies in the sphenomaxillary fossa, close to the sphenopalatine foramen and below the superior maxillary nerve. Its *motor* root comes from the facial through the large superficial petrosal from the geniculate ganglion (see Vidian Nerve), its *sensor* root from the two ganglionic branches of the superior maxillary nerve, and the *sympathetic* root from the carotid plexus through the large deep petrosal. Its branches are as follows:

Ascending.—*Several* through the sphenomaxillary fissure to the orbit. They may supply the periosteum.

Descending.—The *small* or *posterior* runs with a *small* artery in the lesser palatine canal. It supplies the levator palati and azygos uvulæ.

The *large* or *anterior* runs in the posterior palatine canal, thence in branches to the incisor teeth along grooves in the hard palate, and one joins the nasopalatine nerve. It gives off *inferior nasal* branches, through canals in the palate bone, to supply the spongy bones.

The *external* to the outer part of the soft palate, through the external palatine canal.

The **internal branches** include the *nasopalatine* and the *upper nasal* nerves. The latter run through the sphenopalatine foramen to the spongy bones and septum. The *nasopalatine* nerve proceeds with the above, and then descends on the septum nasi, beneath the pituitary membrane, and through the mesial divisions of the anterior palatine canal, called the foramina of Scarpa, the left anterior to the right. They supply the mucous membrane behind the incisor teeth.

The **Vidian** is formed by the large superficial petrosal and the large deep petrosal nerves. The former is a motor branch from the geniculate ganglion of the facial in the aquæductus Fallopii; it passes through the hiatus canalis facialis, enters the cranial cavity, runs in a groove on the anterior surface of the petrous portion of the temporal bone, beneath the dura. It then pierces the cartilaginous substance enclosing the foramen lacerum medium, and joins the large deep petrosal. The large deep petrosal is given off from the carotid plexus, passing external to the internal carotid artery. It pierces the cartilaginous substance of the foramen lacerum medium, and joins the large superficial petrosal. The Vidian begins from the cartilaginous substance of the foramen lacerum medium, then passes through the Vidian Canal, with the artery of the same name, and is joined by a branch from the otic ganglion. It ends in Meckel's ganglion.

Posterior Branches.—The *pharyngeal* nerve passes through the pterygopalatine canal to the mucous membrane of the pharynx.

The **inferior maxillary nerve** (third division of the fifth) is the largest branch, and arises by two roots—a large sensor root from the Gasserian ganglion and the motor root of the fifth. This nerve divides into two trunks, anterior and posterior. The *anterior* gives off the masseteric, the buccal, the deep temporal, and the two pterygoid nerves.

The **masseteric** runs above the external pterygoid, crosses the sigmoid notch to the masseter, supplying also filaments to the jaw.

The **deep temporal** are three, the posterior, middle, and anterior.

The **buccal** is a sensory nerve, and runs along the inner surface of the coronoid process to divide, on the buccinator, into branches to the muscles and skin joining the facial, and extending as far as the angle of the mouth.

The **pterygoid**, internal and external, supply those muscles respectively.

The *posterior* trunk of the inferior maxillary is mostly sensory. It divides into the auriculotemporal, gustatory, and inferior dental.

The **auriculotemporal** runs beneath the external pterygoid, the middle meningeal artery passing up between its two roots of origin to the inner side of the neck on the lower jaw. It then passes up under the parotid gland, and along with the temporal artery over the zygoma, and divides into temporal branches to the skin of the temporal region, joining the facial. This nerve communicates at its origin with the otic ganglion, and gives off the following branches:

Auricular, the inferior to the external meatus, the superior to the tragus and pinna.

Articular, one or two to the articulation of the jaw; several to the *parotid,* and the branches to the external auditory meatus send a filament to the membrana tympani.

The **inferior dental** nerve runs along with the artery, enters that canal, supplies the teeth, and at the mental foramen divides into an *incisor* and a *mental* branch. The former supplies the canines and incisors, the latter the skin of the chin and lower lip. The nerve is at first under the external pterygoid; later, between the ramus of the jaw and the internal lateral ligament. Its branches are the *mylohyoid* and *dentals.* The mylohyoid runs in the groove to supply the mylohyoid and anterior belly of the digastric muscles. The dentals supply the molars and bicuspids, interlacing to form a fine plexus, the inferior dental.

The **gustatory** or **lingual** nerve lies at first beneath the external pterygoid, internal to the dental nerve. Here a branch from the dental may cross the internal maxillary to join it. The chorda tympani also joins it. The nerve now runs along the inner side of the ramus of the jaw, and crosses the upper constrictor to the side of the tongue above the deep part of the submaxillary gland; lastly, it runs below Wharton's duct, and superficially along the side of the tongue to its apex. It communicates with the facial through the chorda tympani, the submaxillary ganglion, inferior dental, and hypoglossal. It supplies the mucous membrane of the mouth and tongue (anterior two-thirds), the gums, sublingual gland, and the filiform and fungiform papillæ.

The **submaxillary ganglion** is placed above the deep part of the gland, and receives filaments from the gustatory and from the inferior maxillary nerve through the chorda tympani; also filaments from the sympathetic plexus around the facial artery.

Branches.—Five or six to gland, Wharton's duct, and the mucous membrane of the mouth.

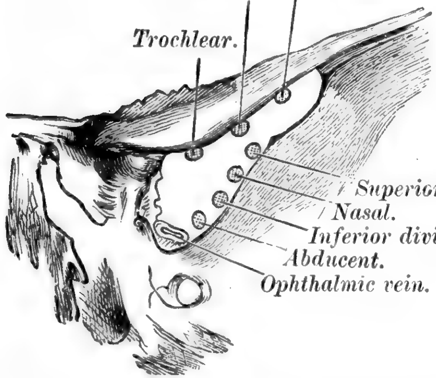
The **otic ganglion** is of a reddish color, oval and flattened in form, and $\frac{1}{6}$ inch in diameter. It lies on the inferior maxillary nerve (deep surface) below the foramen ovale, and behind it is the middle meningeal artery. It communicates with the inferior maxillary through its internal pterygoid branch, with the glossopharyngeal (possibly sensor) and facial (possibly motor) through the small superficial petrosal nerve, continud from the tympanic plexus, and with the plexus on the middle meningeal artery.

Branches.—One to the tensor tympani, to tensor palati, to chorda tympani; and to the auriculotemporal nerve two, and sphenoidal branch to the sphenopalatine ganglion.

The Sixth Nerve

The sixth or abducens has an apparent origin in the groove between the pons and medulla, and a deep origin from the fasciculus teres. It runs to the lower and outer part of the dorsum sellæ, and traverses the floor of the cavernous sinus external to the carotid artery, and, receiving branches from the cavernous and carotid plexuses, enters the orbit by the sphenoidal fissure between the two heads of the external rectus; it receives a branch from the ophthalmic nerve, and supplies the above-named muscles.

FIG. 60



Relations of structures passing through the sphenoidal fissure. (Gray.)

The Seventh Nerve

The seventh or facial has a superficial origin from the depression between the olivary and restiform bodies, and a deep from the fasciculus teres. Between it and the eighth is the *pars intermedia,* which joins the facial in the auditory canal. The nerve runs outward to the internal meatus, where it runs in a groove on the auditory nerve, enters the aquæductus Fallopii, and emerges at the stylomastoid foramen. It presents within the aqueduct, near the hiatus Fallopii, a reddish enlargement, the *geniculate ganglion.* Outside the cranium it runs forward in the parotid gland, and divides behind the ramus into the *cervicofacial* and *temporofacial* divisions. In the parotid and vicinity the radiating branches form the pes anserinus.

Communicating Branches.—In the internal auditory meatus, one or two, communicating with auditory nerve.

In the aqueduct it communicates with Meckel's ganglion by means of the *large superficial petrosal;* with the otic ganglion by a small branch to the *small superficial petrosal;* with the sympathetic, on the middle meningeal, by the *external petrosal;* and with the pneumogastric (auricular branch).

Outside the cranium: it sends branches to the glossopharyngeal, carotid plexus, auricularis magnus, auriculotemporal, and facial nerves.

Branches of Distribution.—In the aqueduct: a *tympanic* branch to the stapedius, and the *chorda tympani.* The latter arises close to the stylomastoid foramen, ascends in a small canal to the posterior wall of the tympanum, and then passes over the upper part of the membrane between the handle of the malleus and the incus, finally emerging through the canal of Huguier; it then descends on the inner side of the internal lateral ligament of the jaw, and joins the gustatory nerve, through which its fibers reach the submaxillary ganglion and lingualis muscle. It receives a branch from the otic ganglion before joining the lingual.

Outside the Cranium.—The *posterior auricular* ascends between the ear and the mastoid, receives a branch from the vagus, one from the auricularis magnus, and one from the occipitalis minor, and divides into an auricular branch to the back of the auricle and retrahens, and an occipital branch to the occipitofrontalis.

The *digastric* branches, to the posterior belly of the digastric, one joining the glossopharyngeal nerve; and a *stylohyoid* branch to the muscle, joining the carotid plexus.

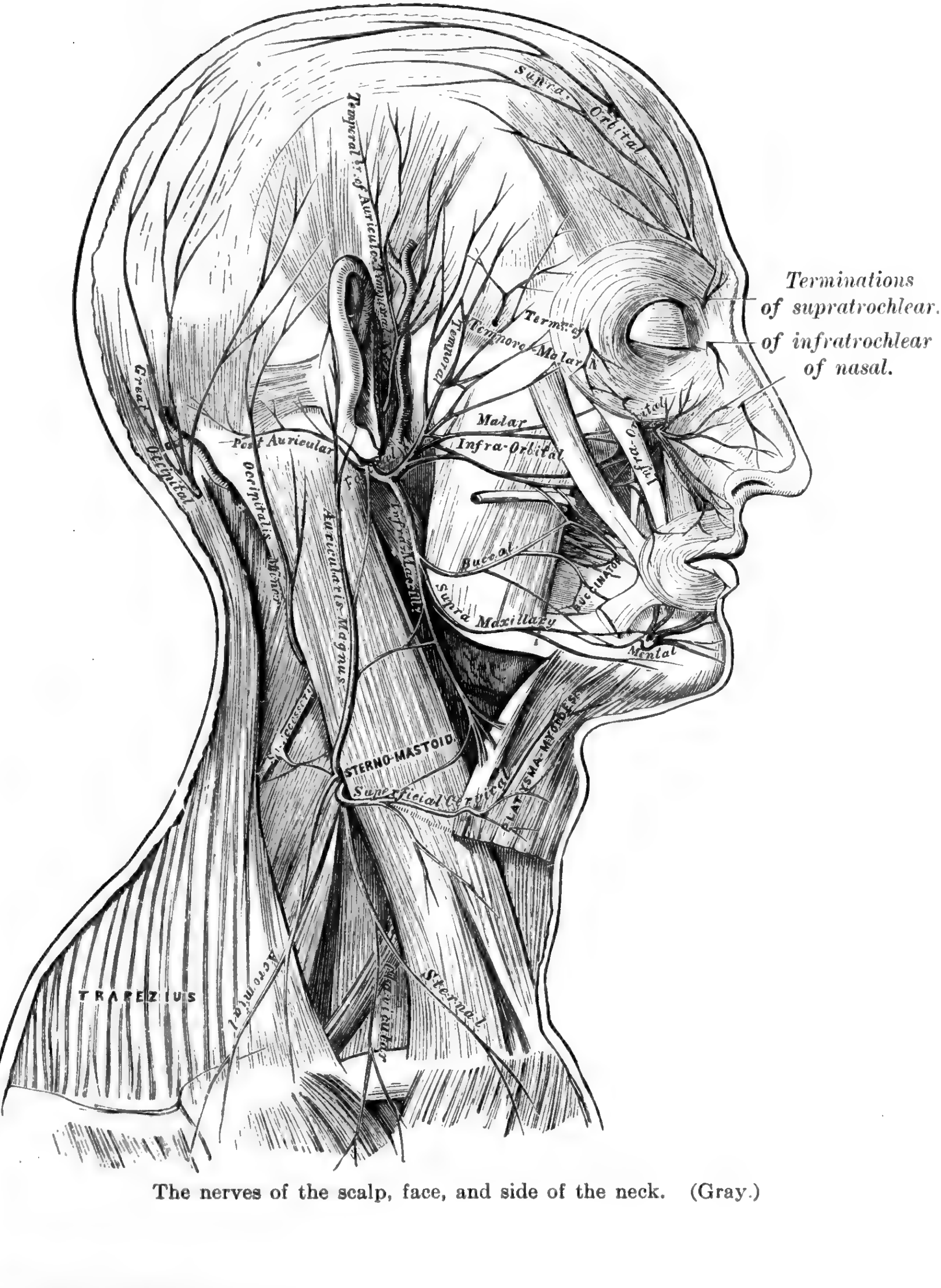
The *temporofacial division* crosses the external carotid artery and the temporomaxillary vein in the upper part of the parotid, receives filaments from the auriculotemporal nerve, and divides into three sets of branches, viz., temporal, malar, and infraorbital.

The *temporal branches* supply the attolens and attrahens, occipitofrontalis, orbicularis, and corrugator supercilii. They communicate with the auriculotemporal, temporal branch of the superior maxilla, and supraorbital nerves.

The *malar branches* run to the outer angle of the orbit, supply the orbicularis and corrugator, joining the lacrymal and supraorbital, and some, to lower lid, join with the superior maxillary nerve (palpebral branches).

The *infraorbital* group, to the space between the orbit and mouth. They supply the buccinator, orbicularis oris, the levator labii superioris, the levator anguli oris, and nasal muscles. They unite with the cervicofacial branches, the nasal, infratrochlear, and with the superior maxillary nerve. The latter forms the infraorbital plexus.

Fig. 61



The nerves of the scalp, face, and side of the neck. (Gray.)

The *cervicofacial* division descends through the parotid, joining branches of the great auricular, and divides, near the angle of the jaw, into buccal, supramaxillary, and inframaxillary branches.

The *buccal* cross the masseter, supply the buccinator and orbicularis oris, and join the infraorbital nerves and the buccal nerve from the inferior maxillary.

The *supramaxillary,* beneath the depressor anguli oris, supplies the inferior labial muscles, and joins branches of the inferior dental.

The *inframaxillary* pierces the deep cervical fascia, supplies the platysma, and forms arches in the suprahyoid region, joining the superficial cervical nerve.

The Auditory Nerve

The eighth or auditory is the special nerve of the sense of hearing. Superficially it appears at the lower border of the pons, external to the facial. It has two roots—one from the inner side of, and one from the front of, the restiform body. It runs to the internal auditory meatus with the facial nerve, the two being separated by the pars intermedia and the auditory artery. The nerve in the meatus divides into a *cochlear* and a *vestibular* branch, whose distributions within the ear are described under the special sense of hearing.

The Ninth Nerve

The ninth or glossopharyngeal arises superficially by several filaments from the dorsolateral groove at the upper part of the medulla; deeply through the lateral tract to a gray nucleus in the floor of the fourth ventricle.

The nerve runs in front of the flocculus to pass through the middle part of the jugular foramen with the vagus and spinal accessory, in a separate sheath, and here presents two successive ganglionic enlargements, the jugular and the petrous ganglia. Outside the cranium it passes between the jugular vein and the internal carotid artery, descending in front of the latter, and beneath the styloid process and its muscles, to the lower border of the stylopharyngeus. It then crosses this muscle and divides into branches beneath the hyoglossus. In the jugular foramen it grooves the lower border of the petrous portion of the temporal.

The *upper* or *jugular ganglion* is of small size, and is formed in the outer part of the nerve, some fibers passing over but not joining it.

The *petrous ganglion* is larger, and lies in a groove in the petrous bone, involving the entire trunk of the nerve. From it pass the *tympanic* nerve and branches of communication to the vagus and sympathetic. That to the sympathetic joins the upper cervical ganglion. To the vagus, one joins its auricular branch and one its upper ganglion. Another branch perforates the posterior belly of the digastric, from a point just below the petrous ganglion, to join the facial close to the stylomastoid foramen.

The *tympanic* (Jacobson's nerve) runs in a canal in the petrous portion to enter the tympanum through an aperture in its floor close to the inner wall, and divides into branches which groove the promontory and form the tympanic plexus. It gives a branch to the *fenestra rotunda, fenestra ovalis,* and to the Eustachian tube. The nerve finally emerges from the tympanum by a canal at its upper and back part, as the *small superficial petrosal* nerve. This latter enters the cavity of the skull by a small foramen on the anterior surface of the petrous portion external to the hiatus Fallopii, and escapes by a small foramen in the great wing of the sphenoid, sometimes the foramen ovale, to join the otic ganglion.

The tympanic nerve sends a communicating branch to the carotid plexus, the *small deep petrosal.*

Branches in the Neck.—The *carotid* branches run on the internal carotid to its commencement at the common carotid, joining the pharyngeal branches of the vagus and the sympathetic.

The *pharyngeal,* three or four, pierce the superior constrictor to the mucous membrane of the upper pharynx.

The *muscular,* to the stylopharyngeus.

The *tonsillitic,* to the tonsil and soft palate, form the circulus tonsillaris and join the palatine nerves.

The *lingual* are the two terminal branches. One supplies the mucous membrane of the posterior third of the tongue and the circumvallate papillæ; the other, to the side of the tongue, joins the gustatory.

The Pneumogastric Nerve

The tenth, vagus, or pneumogastric is both motor and sensory. Its apparent origin is by twelve to fifteen filaments from the groove between the olive and restiform bodies, below, and in the line of the origin of the ninth; its deep origin is from a nucleus in the lower part of the fourth ventricle. It passes through the jugular foramen in the same sheath with the spinal accessory, a partition separating them from the ninth, and develops the *ganglion of the root* of the vagus. Emerging from the foramen, it forms the *ganglion of the trunk* of the vagus.

The *ganglion of the root* (ganglion jugulare) is gray in color and spherical, its diameter about two lines. It has branches of communication with the accessory part of the spinal accessory, with the petrous ganglion of the ninth, with the facial, and with the superior cervical ganglion of the sympathetic.

The *ganglion of the trunk* (ganglion cervicale) is larger, of a reddish color and cylindrical form. Its surface is crossed by the accessory portion of the eleventh, and it communicates with the hypoglossal, the upper two cervical, and the sympathetic nerves.

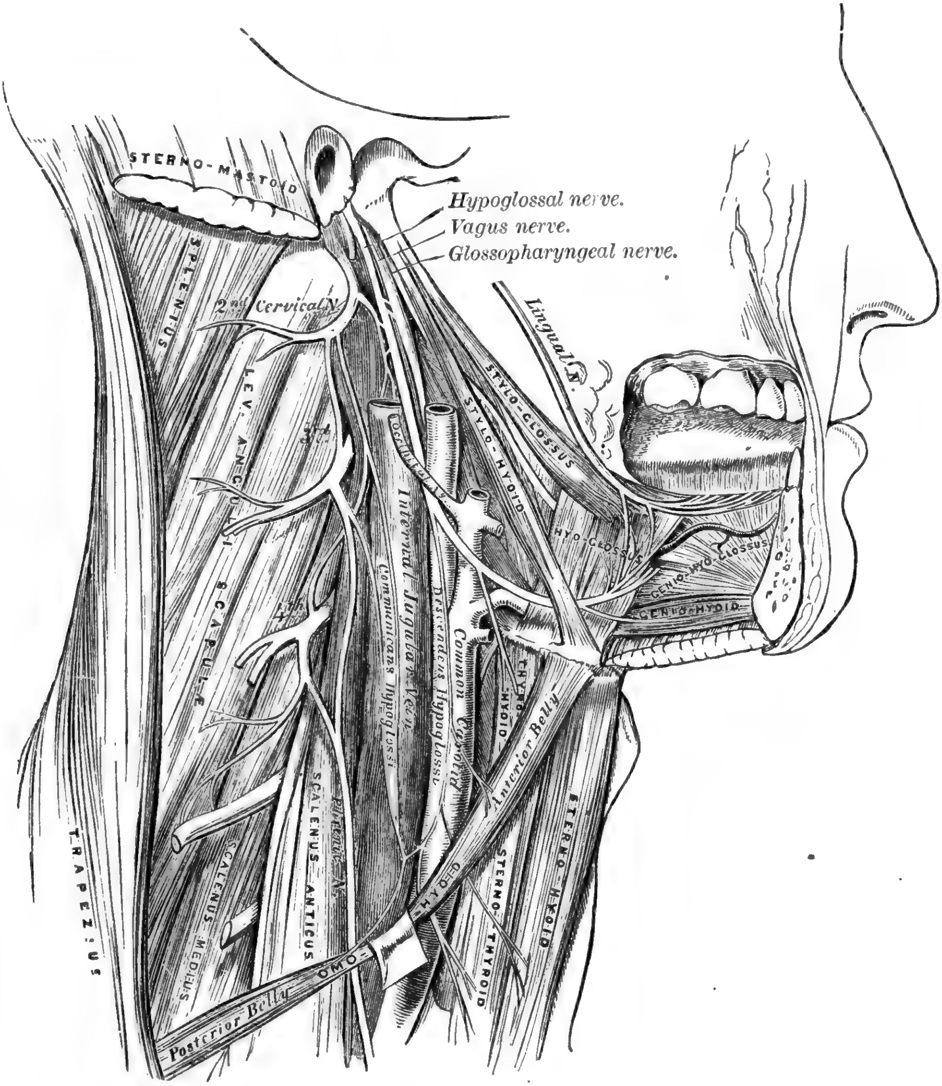
The vagus then descends between the internal carotid artery and the jugular vein to the thyroid cartilage, then between the vein and the common carotid to the root of the neck.

On the right side the nerve crosses the first part of the subclavian artery, descends behind the right innominate vein and alongside of the trachea, and spreads out into the posterior pulmonary plexus behind the root of the lung. Below, two cords emerge from this plexus and ramify on the esophagus, forming, with branches from the left, the esophageal plexus. Again, forming a single trunk, the nerve descends on the back of the esophagus to ramify on the posterior surface of the stomach.

On the left side the nerve runs behind the left innominate vein, between the left carotid and subclavian arteries, and crosses the arch of the aorta. It forms the left posterior pulmonary plexus, assists to form the esophageal plexus, and as a single trunk descends on the front of the esophagus to ramify on the anterior surface of the stomach.

Branches.—(*a*) In the jugular foramen: An *auricular* branch (Arnold's), from the jugular ganglion, receives a branch from

FIG. 62



Hypoglossal nerve, cervical plexus, and their branches. (Gray.)

the petrous ganglion of the ninth, traverses a small canal in the petrous portion of the temporal, crosses the aquæductus Fallopii, and communicates with the facial. It escapes through the auricular fissure, then divides into a branch to the auricle, and a second which joins the posterior auricular. A *recurrent* branch from the jugular ganglion supplies the dura mater in the posterior fossa.

(*b*) In the neck: A *pharyngeal* branch from the cervical ganglion, deriving its fibers mainly from the spinal accessory, crosses the internal carotid, and joins with the glossopharyngeal and sympathetic in the pharyngeal plexus. This plexus supplies the muscles and mucous membrane of the pharynx.

The *superior laryngeal*, from the lower ganglion, runs internal to the internal carotid vessels, receiving branches from the pharyngeal plexus and sympathetic, and divides into the external and internal laryngeal nerves.

The *external* runs beneath the sternothyroid to supply the cricothyroid. It supplies the inferior constrictor, and sends branches to the pharyngeal plexus and superior cardiac nerve.

The *internal* branch pierces the thyrohyoid membrane to supply the mucous membrane of the larynx, and by a long branch joins a similar offset from the recurrent nerve behind the ala of the thyroid cartilage. A twig supplies the arytenoideus.

The *inferior* or *recurrent laryngeal* on the right side arises in front of the subclavian artery and winds backward around that vessel; on the left it rises in front of the arch of the aorta and winds backward around it. Both nerves ascend between the trachea and esophagus, behind the common carotid and inferior thyroid arteries, to the lower border of the cricoid cartilage. They enter the larynx beneath the inferior constrictor, supplying all its intrinsic muscles excepting the cricothyroid, and join the superior laryngeal. Each gives off *cardiac* nerves which join those from the vagus and sympathetic; *tracheal* and *esophageal* branches, and one to the inferior constrictor.

The *cervical cardiac* nerves, two or three, are divided into the *superior*, joining the cardiac branches of the sympathetic, and the *inferior*, one on each side. The right lies in front of the innominate artery, and joins the deep cardiac plexus. The left, in front of the arch of the aorta, joins the superficial cardiac plexus.

(*c*) In the chest: The *thoracic cardiac* branches, the right from the trunk of the vagus and from the recurrent branch, the left from the latter only. They join the deep cardiac plexus.

Pulmonary nerves, two or three anterior, join the sympathetic and form the anterior plexus on the root of the lung. The posterior, larger and more numerous, join branches from the second, third, and fourth thoracic ganglia to form the posterior plexus. Offsets from these nerves accompany the bronchi throughout the lung.

The *esophageal*, above and below the preceding. The lower and larger branches come from the esophageal plexus.

(*d*) *Gastric branches:* These are the terminal branches of the vagi. The right, to the posterior surface, join the celiac, splenic, and left renal plexuses. The left, to the anterior surface and lesser curvature, join the right nerve, the sympathetic, and the hepatic plexus.

The Eleventh Pair

The eleventh, or spinal accessory, consists of a *spinal* portion and an *accessory part* to the vagus. The *latter* part arises as five or six filaments from the lateral tract of the medulla, below the origin of the vagus. It sends some filaments into the ganglion jugulare of the vagus, and joins that nerve below the ganglion cervicale, being continued, for the most part, into the pharyngeal and superior laryngeal branches.

The *spinal portion* arises from the lateral column of the cord as low as the sixth cervical nerve, the fibers being connected with the anterior horn of gray matter. This part then ascends, between the posterior nerve roots and the ligamentum denticulatum, through the foramen magnum, then out again by the jugular foramen, lying in the sheath of the vagus, and here communicates with the accessory portion. After its exit from the skull it crosses the internal jugular vein and pierces the sternomastoid to end in the trapezius.

The Hypoglossal

The twelfth, or hypoglossal, nerve arises by ten to fifteen filaments from the groove between the pyramidal and olivary bodies. The deep origin is from a nucleus in the floor of the fourth ventricle. The filaments form two bundles which pierce the dura separately and unite in the anterior condylar foramen. The nerve descends behind the internal carotid artery and internal jugular vein, closely bound to the vagus, then passes forward between the artery and vein, and becomes superficial below the digastric, curving around the occipital artery. It now crosses the external carotid and lingual arteries, runs between the mylohyoid and hyoglossus, communicates with the gustatory nerve, and, after piercing the genioglossus, breaks up into filaments to the substance of the tongue.

Branches of communication pass to the vagus, superior cervical ganglion of the sympathetic, to the loop between the first and second cervical, and to the gustatory nerves.

Branches of Distribution.—Descendens hypoglossi leaves the nerve as it crosses the occipital artery, descends within or in front of the carotid sheath, and, joining the ansa hypoglossi, forms a loop from which the sternohyoid and thyroid and both bellies of the omohyoid are supplied. Its origin may be traced to the first and second cervical nerves.

The *thyrohyoid* branch crosses the great cornu of the hyoid bone, to supply the muscle.

Muscular branches pass to the styloglossus, hyoglossus, geniohyoglossus, and geniohyoid muscles.

Meningeal branches run to the posterior fossa, leaving the nerve at the foramen.

THE SPINAL NERVES

The spinal nerves consist, on each side, of eight cervical, twelve dorsal, five lumbar, five sacral, and one coccygeal, in all thirty-one pairs, which arise from the cord by two roots, *anterior* and *posterior*. The latter are the larger and are supplied with ganglia. The suboccipital or first cervical nerve has no ganglion. The two roots unite just beyond the ganglion, and the resulting *trunk* divides into *two divisions*, anterior and posterior, each containing fibers from both roots. The *posterior division* divides into an *external* and an *internal* branch. The *anterior divisions* in the dorsal region remain separate, but elsewhere they unite into plexuses. They are larger than the posterior. Each division is connected with the sympathetic.

The Cervical Nerves

Of the posterior divisions, that of the *first* or *suboccipital* does not divide into an external and internal branch. It crosses the atlas to the suboccipital triangle, and supplies the complexus (in part), the obliqui, and posterior recti, a branch joining the second nerve. Of the *other* nerves, the *external* branches supply the splenius, transversalis colli, cervicalis ascendens, and trachelomastoid. The *internal*, except that of the second, run inward; those of the third, fourth, and fifth, between the complexus and semispinalis, supply them and the multifidus and the skin over the trapezius. The *internal branches* of the sixth, seventh, and eighth run beneath the semispinalis, and supply no cutaneous branches. The internal branch of the second, known as the *great occipital nerve,* pierces the trapezius and complexus (in part), supplies the latter, and runs with the occipital artery supplying the back of the head, and sends a branch to the small occipital.

The Cervical Plexus

The cervical plexus is formed by the anterior divisions of the upper four cervical nerves, which emerge between the scalenus medius and rectus anticus major. It lies upon the scalenus medius and levator anguli scapulæ, beneath the sternomastoid. Each nerve except the first divides into a branch for the nerve above and one for the nerve below. The anterior division of the first (suboccipital) nerve grooves the atlas beneath the vertebral artery, and joins the second, supplying the rectus lateralis and recti antici. It communicates with the sympathetic, vagus, and hypoglossal nerves.

Its branches are *superficial* and *deep.*

The *superficial* are divided into ascending and descending.

1. Ascending Branches.—(*a*) The **superficialis colli,** from the second and third nerves, crosses the sternomastoid, and divides under the platysma into two branches, an upper and a lower, which ramify in the skin of the front of the neck, from the maxilla to the sternum.

(*b*) The **auricularis magnus,** from the second and third, runs over the sternomastoid to the parotid region, and supplies *facial* branches to the skin over the parotid, a *mastoid* branch to the skin in that region, and *auricular* branches to the lobule and back of the auricle. By these branches the nerve also communicates with the facial and small occipital.

(*c*) The **occipitalis minor,** from the second and third (sometimes only the second), runs along the posterior border of the sternomastoid to the head and supplies the scalp. It communicates with the great occipital and the great and posterior auricular nerves, and gives a branch to the auricle.

Fig. 63

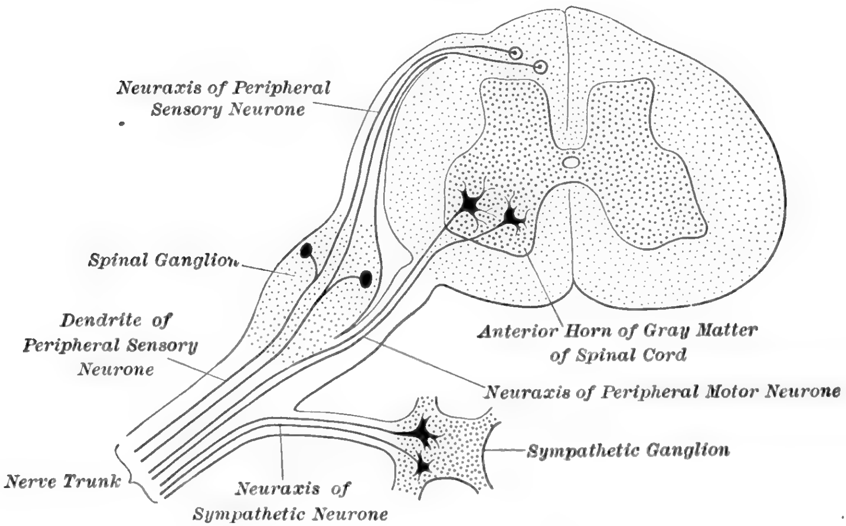


Diagram to show the composition of a peripheral nerve trunk. (Böhm and Davidoff.)

2. Descending Branches.—These are the supraclavicular nerves. They arise from the third and fourth cervical, and divide into the *suprasternal, supraclavicular,* and *supraacromial branches,* which descend between the trapezius and sternomastoid to supply the skin over the regions indicated by their names.

The *deep* branches consist of an *external* and an *internal* series.

The external include **muscular,** to the sternomastoid (from the second); trapezius, scalenus medius, and levator anguli scapulæ (from the third and fourth), and **communicating,** which join the spinal accessory within the sternomastoid and trapezius, and also between these two muscles.

The INTERNAL are: **Communicating,** from the loop between the first and second, to the vagus, hypoglossal, and sympathetic, and a branch from the fourth to the fifth.

Muscular, to the lateral and anterior recti muscles (from the first and second).

Communicantes hypoglossi, generally two, one from the second and one from the third, pass under or over the internal jugular to join the descending branch from the hypoglossal nerve.

Phrenic, from the third, fourth, and fifth, descends on the scalenus anticus, then between the subclavian artery and vein, and crosses the internal mammary artery. It then crosses in front of the root of the lung and runs between the pericardium and mediastinal pleura to the diaphragm; it communicates with the sympathetic, descendens noni, and the nerve to the subclavius. The *right* is deeper than the left. It runs external to the innominate vein and superior vena cava. The *left* crosses the front of the aortic arch and the left vagus. Both phrenics supply the diaphragm, pleura, and pericardium. Filaments from the right, with the phrenic branches of the solar plexus, form a ganglion, which sends branches to the suprarenal capsules and inferior vena cava and to the hepatic plexus; on the left side there is no ganglion.

The Brachial Plexus

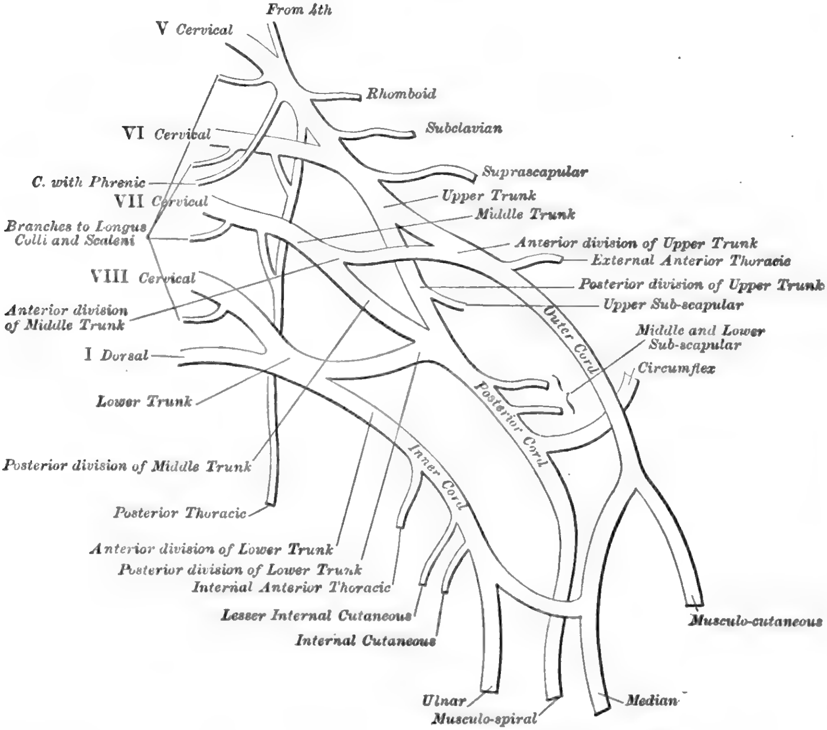
The brachial plexus is formed by the anterior divisions of the lower four cervical and first dorsal, as follows: The fifth and sixth form an upper; the seventh, a middle; and the eighth cervical with first dorsal, a lower trunk. Each of these trunks then separates into an anterior and a posterior branch.

The anterior branches of the upper and middle trunks form the *outer cord* of the plexus; the anterior branch of the lower, the *inner cord;* of the posterior cord it is variously stated that the posterior branches of all three trunks form it, or that the posterior branches of the upper and middle trunks form it, while the posterior branch of the lower trunk joins the musculospiral nerve. It is altogether a matter of dissection.

The plexus is at first between the anterior and middle scaleni, then above and external to the subclavian artery. It passes behind the clavicle and subclavius, lying on the subscapularis and serratus magnus. The *cords* lie external to the first part of the axillary artery, but on three sides of the second part of that vessel.

BRANCHES ABOVE THE CLAVICLE.—A *branch from the fifth* joins the phrenic, and **muscular** branches supply the scaleni, longus colli, rhomboidei, and subclavius. The *branch* to the

FIG. 64



Plan of the brachial plexus. (Gray.)

subclavius, from the trunk formed by the fifth and sixth cervical, crosses the subclavian artery, its third part, and sends a branch to the phrenic nerve.

The **posterior thoracic** nerve, from fifth and sixth cervical, runs out of the scalenus medius and descends behind the clavicle upon the serratus magnus, which it supplies.

The **suprascapular** nerve, from the fifth and sixth, enters the supraspinous fossa by the notch, supplies an *articular* branch and one to the muscle, also a branch to the infraspinous fossa and muscle.

BRANCHES BELOW THE CLAVICLE.—The *three cords* give off the following nerves: The outer, the musculocutaneous, outer head of the median, external anterior thoracic; the inner, the internal anterior thoracic, inner head of median, internal and lesser internal cutaneous, and the ulnar; the posterior, the musculospiral and circumflex, and subscapular.

The **anterior thoracic** nerves supply the pectoral muscles. The *external* comes off from the outer cord, crosses the axillary artery, and gives a branch to the inner nerve, and ends in the pectoralis major, to which it is distributed. The *internal* comes off from the inner cord, runs forth between the artery and vein, and joins the branch from the external, forming a loop around the artery. It supplies the pectoralis minor, a portion of it passes on through this muscle to the great pectoral, completing its nerve supply.

The **subscapular**: The *upper* (from the posterior branch of the upper trunk) supplies the subscapularis at its upper part; the *middle* or *long* accompanies the subscapular artery to the latissimus dorsi; and the *lower* (from posterior cord) supplies the subscapularis, entering its axillary margin, and teres major.

The **internal cutaneous** (from inner cord), on the inner side of the axillary artery, divides at the middle of the arm into an *anterior* branch, crossing over or under the median basilic vein, which supplies the forearm as far as the wrist, and a *posterior*, which winds above the inner condyle to back of humerus, and runs to lower part of forearm. This nerve communicates with the lesser nerve and the ulnar, and supplies the skin over the biceps.

The **lesser internal cutaneous** (of Wrisberg), from the inner cord, runs behind and then internal to the axillary vein and joins the intercostohumeral nerve. It then runs along the inner side of the brachial artery, and supplies the skin as far as the olecranon and internal condyle.

The intercostohumeral bears a complementary relation, in point of size, to the lesser nerve, and may even replace it altogether.

The **circumflex nerve,** from the posterior cord, is at first behind the axillary artery. It winds back through the space bounded by the triceps, humerus, and the two teres muscles, gives a filament to the shoulder-joint, and divides into two branches, an *upper* and a *lower*. The *former* winds around the humerus to the anterior border of the deltoid, supplying it and the skin, and the *latter* supplies the skin over the lower two-thirds of the deltoid as well as the muscle, and gives a branch to the teres minor, upon which a ganglion is developed.

The external or **musculocutaneous nerve** arises from the outer cord opposite the lower border of the pectoralis minor, and runs through the *coracobrachialis* and over the *brachialis anticus* to pierce the fascia at the outer border of the *biceps,* a little above the elbow. It then runs behind the median cephalic vein and divides into two branches, *anterior* and *posterior.*

In the arm it supplies the three muscles mentioned above, a *filament* to the *elbow-joint,* and one to the *humerus.*

The *anterior* branch crosses the radial artery at wrist and joins a branch of the radial nerve and the palmar cutaneous branch of the median. It supplies the skin over the radius and twigs to the artery. The *posterior* branch descends along the back of the forearm to the wrist and joins branches of the radial and musculospiral nerves.

The **median nerve** arises by two roots, an outer from the outer cord and an inner from the inner cord, which unite in front of or to the outer side of the axillary artery. It lies to the outer side of the brachial artery above and crosses over (or under) it to its inner side. It passes between the two heads of the pronator teres, running on the flexor profundus and beneath the annular ligament into the hand. At the wrist it lies behind and to the ulnar side of the palmaris longus.

Branches.—1. *In the arm,* none.

2. *In the forearm* it supplies all the *superficial flexor muscles* except the flexor carpi ulnaris; some filaments to the elbow-joint; some of the filaments to the muscles may come off a little above the elbow.

The *anterior interosseous* nerve comes off a little below the elbow and runs along the interosseous membrane with the artery of that name. It supplies the flexor longus pollicis and the outer half of the flexor profundus digitorum muscles, between which it lies, and also the pronator quadratus, in which it ends.

The *palmar cutaneous* branch pierces the fascia above the annular ligament, and supplies the skin over the ball of the thumb and the palm. It communicates with branches of the ulnar and external cutaneous nerves.

3. *In the palm* the nerve lies on the flexor tendons, covered by the annular ligament, and becomes larger and reddish in color. It divides into two branches—the *external*, supplying some of the muscles of the thumb and digital branches to the thumb and index finger; and the *internal*, supplying digital nerves to the index, middle, and ring fingers.

The *muscular* branches supply the abductor, opponens, and outer head of the flexor brevis pollicis. The *first digital*, with the second, supplies the thumb, the former joining a branch of the radial. The *third*, along the radial side of the index finger, supplies it and the first lumbricalis. The *fourth* supplies the adjacent sides of the index and middle fingers and the second lumbricalis. The *fifth*, to the adjacent sides of the middle and ring fingers, joins a branch of the ulnar. Each digital nerve divides at the tip of the finger into a branch to the pulp and one to the matrix of the nail. At the base of the first phalanx each sends a branch to the back of the second and third phalanges.

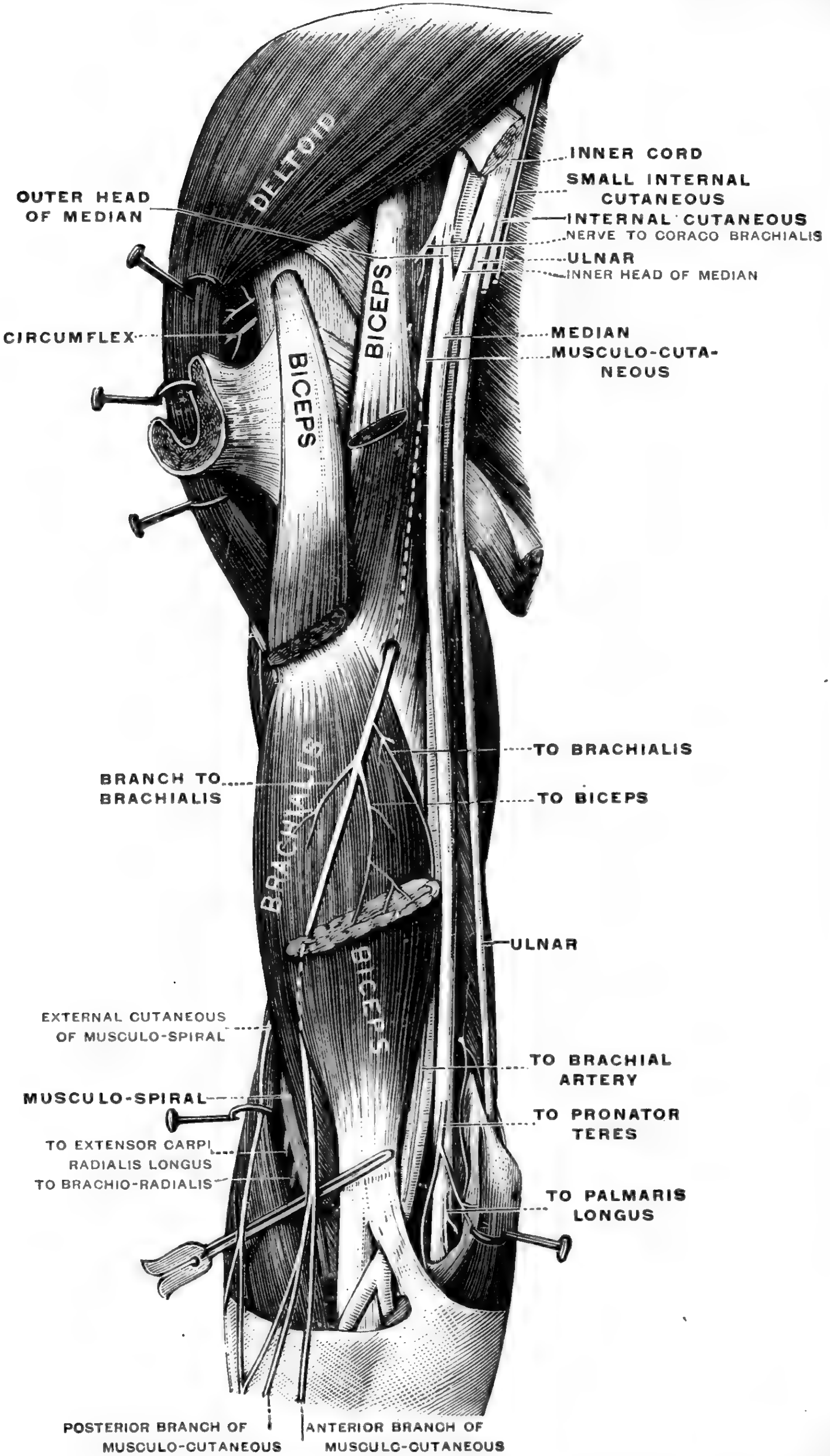
The **ulnar nerve** from the inner cord runs internal to the axillary and brachial arteries as far as the middle of the arm. It then passes on the inner head of the triceps to the groove between the olecranon and internal condyle with the inferior profunda artery, and runs between the two heads of the flexor carpi ulnaris with the posterior ulnar recurrent artery, lying beneath the muscle above and to the radial side of it below. In the lower two-thirds of the forearm the ulnar artery is external. The nerve then crosses the annular ligament between the artery and pisiform bone, and divides into a *superficial* and a *deep* branch.

Branches.—1. *In the arm,* none.

2. *In the forearm,* several *articular* to the elbow. *Muscular,* to the flexor carpi ulnaris and inner half of the flexor profundus. *Two cutaneous* by a common trunk. One joins a branch of the internal cutaneous, and the other, the *palmar cutaneous,* runs on the ulnar artery to the palm, joining branches of the median nerve.

The *dorsal cutaneous* comes off about two inches above the wrist, runs backward beneath the flexor carpi ulnaris, and

FIG. 65



Deep nerves of the front of the right arm. (Testut.)

supplies dorsally the little and inner half of the ring finger. The latter communicates with the contiguous branch of the radial.

3. *In the palm* are the *superficial* and *deep* branches. The *former* supplies the skin and palmaris brevis and digital branches to the little and inner half of the ring fingers, the latter joining a branch of the median. The *latter*, passing between flexor brevis and abductor minimi digiti, supplies all the muscles of the hand except those supplied by the median nerve, and sends filaments to the wrist-joint.

The **musculospiral nerve** is from the posterior cord and runs behind the axillary and brachial vessels, and, later, in the musculospiral groove with the superior profunda artery, pierces the external intermuscular septum to the anterior aspect of the arm, then between the brachialis anticus and supinator longus. In front of the outer condyle it divides into the *radial* and *posterior interosseous* nerves.

Branches.—Muscular and cutaneous.

Muscular Branches.—These leave the nerve, as their names imply, at the inner, posterior, and outer parts of the arm. The *internal* supplies the inner and middle heads of the triceps; the *posterior* supplies the outer head of the triceps and the anconeus; the *external* supplies the supinator longus, extensor carpi radialis longior, and the brachialis anticus.

Cutaneous Branches.—The *internal* arises before the nerve enters the musculospiral groove, supplies the inner side of the posterior aspect of the arm; the *two external* pierce the outer head of the triceps close to its origin. The *upper* supplies the lower part of the upper arm; the *lower*, the lower half of the arm, forearm, and wrist dorsally, joining the posterior branch of the musculocutaneous.

The **radial nerve** is a purely sensory nerve, it is overlapped by and runs parallel with the supinator longus, finally runs backward beneath its tendon, just above the wrist, pierces the fascia, and divides into two branches. Of these, the *external* supplies the radial side and ball of the thumb, and joins a branch of the musculocutaneous; the *internal*, after communicating with the musculocutaneous, supplies dorsally digital branches to the thumb and index, index and middle, middle and outer half of the ring fingers.

This last joins with the contiguous branch of the dorsal cutaneous of the ulna, and they all terminate at the base of the second phalanx.

The **posterior interosseous** passes between the planes of the supinator brevis, around the outer side of the neck of the radius, and runs beneath the superficial muscles on the back of the forearm and on the lower part of the interosseous membrane. It supplies all the muscles of the back and outer part of the forearm except the supinator longus, extensor carpi radialis longior, and the anconeus, and terminates at the wrist in a ganglion from which are supplied the carpal ligaments and joint.

The Dorsal Nerves

The *posterior* divisions in the *dorsal* region: The *external* branches increase in size from above downward, pierce the longissimus dorsi to supply the erector spinæ group, and those of the lower six, the skin. The internal branches of the six upper supply the multifidus and semispinalis dorsi and the skin. The six lower internal supply the multifidus, but not the skin.

The Anterior Divisions of the Dorsal Nerves

First Dorsal.—The anterior division in part joins the brachial plexus, and the remainder of the nerve forms the first intercostal, which has no lateral cutaneous branch.

The UPPER SIX are called the **pectoral intercostal nerves,** and lie below the vessels. At first they run between the pleura and the external intercostal muscles, then between the two planes of muscles to the middle of the rib, here giving off the *lateral cutaneous* nerves. The nerves now enter the substance of the internal intercostals as far as the cartilages, where they lie between the muscles and the pleura. Finally they cross the internal mammary vessels and the triangularis sterni, pierce the internal intercostals and pectoralis major, and end in the skin of the chest, as the *anterior cutaneous* nerves of the thorax.

Branches.—Muscular, to the intercostals, triangularis, levatores costarum, and serratus posticus superior.

The **lateral cutaneous** are given off about midway to the sternum, pierce the serratus magnus and external intercostals, and each divides into two branches, anterior and posterior.

The *anterior* runs to the skin over upper part of the external oblique, mamma, and skin; the *posterior,* to the skin over the scapula and latissimus dorsi.

The lateral cutaneous of the *second dorsal* crosses to the arm, joins the nerve of Wrisberg, pierces the fascia, and supplies the skin of the upper half of the inner and back part of the upper arm, joining the cutaneous branch of the musculospiral nerve. This nerve is generally called the *intercostohumeral.* It has no *anterior* division.

The LOWER SIX, or abdominal intercostals, run from the intercostal spaces behind the cartilages, between the internal oblique and transversalis, to the rectus, which they enter. They supply the intercostals, serratus posticus inferior, abdominal muscles, and end in the skin, as the *anterior cutaneous* nerves of the abdomen.

The **lateral cutaneous** branches have a similar distribution to those in the chest.

The LAST DORSAL nerve is altogether abdominal. It crosses the quadratus lumborum and runs into the abdominal wall like the lower intercostals. It communicates with the iliohypogastric and with the first lumbar nerve (*dorsolumbar*). Its **lateral cutaneous** branch supplies the skin of the forepart of the gluteal region as low as the great trochanter.

Each dorsal nerve is joined by short communicating branches from the sympathetic.

The Lumbar Nerves

The Posterior Division.—In the *lumbar* region the *internal* branches end in the multifidus. The *external* supply the intertransverse muscles and erector spinæ, and the upper three a portion of the skin over the gluteal region.

The Anterior Divisions of the Lumbar Nerves.—The *first* unites with a branch from the last dorsal, the *dorsolumbar nerve,* and then proceeds, together with the *second, third,* and *fourth,* to form the lumbar plexus. The *fifth* joins the sacral plexus. They are joined by the sympathetic filaments, and furnish branches to the psoas and quadratus muscles.

The Lumbar Plexus

The **lumbar plexus** is formed in the substance of the psoas muscle, in the following manner: Each of the first four lumbar nerves divides into an *upper* and a *lower* branch. Just before dividing the *first* receives the dorsolumbar nerve, and the *third* and *fourth* send each a branch to the nerve below.

The *upper* branch of the first subdivides into the *iliohypogastric* and *ilioinguinal* nerves. The *lower* branch of the first passes downward and subdivides into two branches, one of which unites with the *upper* branch of the second to form the *genitocrural* nerve. The other unites with the *lower* branch of the second to form a cord. This cord passes downward, and gives off the *external cutaneous* nerve and a branch to the obturator, after which it unites with the upper branches of the third and fourth to form the *anterior crural* nerve. The lower branches of the third and fourth unite to form the *obturator* nerve.

The **iliohypogastric** escapes at the upper part of the psoas, crosses the quadratus, pierces the transversalis at the iliac crest, and divides, between it and the internal oblique, into two branches. The *iliac* branch supplies the skin over the glutei, behind the lateral cutaneous of the last dorsal; the *hypogastric* branch communicates with the ilioinguinal, and pierces the oblique muscles to supply the skin of the pubic and hypogastric regions.

The **ilioinguinal** crosses the quadratus and iliacus below the preceding, pierces the transversalis, communicating with the iliohypogastric, and runs in the inguinal canal, supplying the skin of the groin, scrotum, and penis (the labium in the female).

The **genitocrural** runs downward through and on the psoas muscle, and divides some distance above Poupart's ligament into a *genital* and a *crural* branch. The *former* lies on the external iliac artery, sending filaments around it, and runs with the cord through the inguinal canal to the cremaster muscle; in the female it runs on the round ligament. The *crural* branch runs under Poupart's ligament into the thigh, sending filaments around the femoral artery, and lying superficial to the artery in the femoral sheath. It supplies the skin of the upper thigh, and joins the middle cutaneous.

The **external cutaneous** crosses the iliacus and enters the thigh through the notch below the anterior superior spine of the ilium, superficial to the sartorius, dividing into an *anterior* and a *posterior* branch. The *former* runs in a canal within the fascia lata, and becomes cutaneous four inches below Poupart's ligament. It supplies the front and outer part of the thigh to the knee, sometimes joining in the patellar plexus. The *posterior* branch supplies the skin of the outer and back part of the thigh halfway to the knee.

The **obturator nerve** emerges from the inner border of the psoas at the pelvic brim. It runs above the obturator vessels to escape at the upper part of the obturator foramen, dividing into two branches separated by the adductor brevis. The *anterior* runs beneath the pectineus and adductor longus, joining at the lower part of the latter with branches of the long saphenous and internal cutaneous nerves to form a plexus. A *branch* supplies the *hip-joint; muscular branches* to gracilis and adductor longus, sometimes to the adductor brevis and pectineus; the terminal branch to the femoral artery.

The *posterior* branch pierces the obturator externus and runs behind the adductor brevis on the adductor magnus, and supplies these muscles (the adductor magnus only in part). A branch to the knee-joint pierces the magnus, lies on the popliteal artery, sending branches to it, and pierces the ligamentum Winslowii to supply the synovial membrane.

The **accessory obturator** is inconstant; when present it arises by branches from the second, third, and fourth nerves, or is a branch of the obturator. It runs along the inner border of the psoas, and, crossing the pubes, divides beneath the pectineus into three branches—one to the anterior branch of the obturator, another to the hip-joint, and a third to the pectineus. It is not constant.

The **anterior crural nerve** is the largest branch of the lumbar plexus. It enters the thigh between the psoas and iliacus, external to the femoral artery, and divides into an *anterior* (mainly cutaneous) and a *posterior* (mainly muscular) portion.

Branches.—Within the abdomen, three or more branches to the iliacus, and a branch to the femoral artery.

Anterior Portion.—(*a*) The *middle cutaneous* pierces the fascia lata four inches below Poupart's ligament, and divides into two branches which run on the front of the thigh to the patella.

It joins the crural branch of the genitocrural and the internal cutaneous nerves.

(*b*) The *internal cutaneous* crosses the femoral artery and divides into two branches, anterior and posterior. It supplies several cutaneous filaments which follow the course of the long saphenous vein, one reaching to the knee. The *anterior* branch runs to the knee, perforating the fascia lata low down, and, crossing the patella to its outer side, communicates with a branch of the long saphenous nerve. The *posterior* branch runs along the posterior border of the sartorius, communicates with the internal saphenous nerve, and supplies the skin of the inner side of the thigh (lower part) and leg. It perforates the fascia lata at inner side of knee. It also joins branches of the obturator beneath the fascia.

(*c*) Branch to the pectineus passing behind the femoral vessels.

(*d*) Branches to the sartorius from the middle cutaneous.

Posterior Portion.—(*a*) Branch to the rectus femoris; also sends a twig to the hip-joint.

(*b*) Branch to the vastus externus.

(*c*) Branches to the crureus: One of these sends a filament to the knee-joint.

(*d*) Branch to the vastus internus accompanies the saphenous nerve and sends a filament to the knee-joint.

(*e*) The *internal saphenous* nerve accompanies the femoral vessels, being at first external to and later crossing the artery. It then runs beneath the sartorius to the inner side of the knee, pierces the fascia, and accompanies the saphenous vein along the inner side of the leg. Passing in front of the inner ankle, it ends on the inner side of the metatarsus. It communicates with the obturator and internal cutaneous nerves.

Branches supply the skin of the leg. The terminal branches communicate with the musculocutaneous, and a *patellar* branch spreads out over the knee and joins in the patellar plexus.

The Sacral and Coccygeal Nerves

The Posterior Divisions.—In the *sacral* region, of the *upper three*, the *internal* branches end in the multifidus spinæ, and the *external* anastomose with the fourth sacral and last lumbar. They send off filaments over the great sciatic ligament, finally ending in the skin by two branches.

The *last two* do not divide, but join the coccygeal nerve.

The posterior division of the *coccygeal* nerve ends with the above, and supplies the skin over the coccyx.

The Anterior Divisions.—The anterior division of the *fifth lumbar* receives a branch from the fourth, and, under the name of the *lumbosacral* cord, joins the first sacral.

The anterior divisions of the *first four* sacral nerves escape by the anterior sacral foramina; the *fifth*, between the sacrum and coccyx; all join with filaments from the sympathetic.

The first *three*, with a branch from the fourth, enter into the formation of the sacral plexus.

The *fourth*, its remaining portion, sends branches to the bladder and adjacent viscera, and supplies the levator ani, coccygeus, external sphincter (see Perineal and the Hemorrhoidal Nerve), and skin of the perineum. It also sends a branch to the fifth sacral. The visceral branches unite with occasional branches from the third sacral and with the sympathetic.

The *fifth* sacral pierces the coccygeus, supplying it and the skin over the coccyx. Branches from the fourth sacral and the coccygeal nerve join it.

The anterior division of the *coccygeal* nerve, very small, pierces the coccygeus and sacrosciatic ligaments, and terminates by uniting with the fifth sacral.

The Sacral Plexus

The **sacral plexus** is formed by the anterior divisions of the *first, second, third,* and *part* of the *fourth* sacral nerves, together with the lumbosacral cord.

The **lumbosacral cord,** with the first, second, and part of the third sacral nerve, is continued into the upper great branch of the plexus, and the remainder of the plexus forms the lower or smaller branch.

Branches.—Besides these two principal branches, which are, respectively, the *great sciatic* and the *pudic* nerves, the upper nerves of the plexus give off the nerves of the *pyriformis, quadratus, femoris, obturator internus,* and *gemelli,* as well as the *superior* and *inferior gluteal, small sciatic,* and a *perforating cutaneous* branch.

The muscular branch to the *obturator internus* crosses the spine of the ischium and enters the small sciatic foramen to the inner surface of the muscle. It also supplies the *superior gemellus.* That to the *quadratus femoris* runs beneath the tendon of the obturator internus, and supplies also the *inferior gemellus* and hip-joint. Lastly, the *pyriformis* receives several filaments from the sacral nerves previous to the formation of the plexus.

The **superior gluteal** emerges above the pyriformis, through the great sciatic notch, and divides into an *upper* branch, to the gluteus medius, and a *lower,* larger branch, which supplies both the medius and minimus, piercing the latter to end in the tensor vaginæ femoris. It arises from the lumbosacral cord and first sacral nerve.

The **inferior gluteal** emerges below the pyriformis, dividing into numerous branches for the gluteus maximus. It sends a branch to join the small sciatic. It arises from the lumbosacral cord and first and second sacral nerves.

The **small sciatic** is purely sensor; it appears below the pyriformis, and runs beneath the gluteus maximus upon the great sciatic nerve, thence beneath the fascia lata, which it pierces just below the knee. It communicates with the external saphenous nerve. It arises from the second and third sacral nerves.

Branches.—*Cutaneous,* to the calf of the leg, to the inferior gluteal region, and to the back and inner part of the thigh (*femoral cutaneous*); and the *inferior pudendal* nerve, derived below the tuber ischii, to the scrotum or labium majus and the skin of the upper and inner part of the thigh.

The **perforating cutaneous nerve,** from the fourth sacral nerve, pierces the great sciatic ligament and turns over the lower border of the gluteus maximus to supply the skin over its lower part.

The **pudic nerve** emerges between the coccygeus and pyriformis, and crosses the ischial spine to re-enter the pelvis by the lesser sacrosciatic foramen. It divides, in the ischiorectal fossa, into the *inferior hemorrhoidal, perineal,* and *dorsal nerve* of the *penis* or *clitoris.*

The *inferior hemorrhoidal* supplies the external sphincter (in part) and the skin of the back part of the perineum, communicating with the pudendal and perineal nerves.

The *perineal* runs in a sheath of the obturator fascia along the outer wall of the ischiorectal fossa, and divides into *superficial* and *deep* branches. The *latter* supply the external sphincter (in part, see Fourth Sacral) and the muscles of the perineum, sending a branch to the mucous membrane of the urethra, which pierces the corpus spongiosum.

The *superficial* branches are external and internal. The former supplies the scrotum and inner side of the thigh, and the latter runs nearer to the middle line and supplies the skin of the scrotum. Both the superficial perineal nerves communicate with the pudendal and hemorrhoidal branches, and in the female end in the labia majora.

The *dorsal nerve* of the penis (in the female, of the clitoris) accompanies the pudic artery, and runs along the dorsum to the glans. It supplies branches to the constrictor urethræ to the integument of the penis, and to the corpus cavernosum. On the penis it receives branches from the sympathetic. In the female the analogue of this nerve is smaller, with a like distribution.

The **great sciatic nerve** is the largest nerve in the body, and includes fibers from the greater part of the sacral plexus. From the lower border of the pyriformis it descends on the gemelli, obturator internus, and quadratus, then on the adductor magnus, being covered by the gluteus maximus and long head of the biceps, and accompanied by the small sciatic nerve and the sciatic artery. It divides at the lower third of the thigh into the *external* and *internal popliteal nerves.* It supplies the biceps, semitendinosus and semimembranosus, adductor magnus (in part), and hip-joint (in part).

The **internal popliteal nerve** is the larger branch of bifurcation of the great sciatic. It runs along the middle of the popliteal space to the lower border of the popliteus, where it becomes the posterior tibial. It is at first external to, then behind, and lastly internal to, the popliteal artery.

Branches.—Three *articular,* one accompanying the azygos articular artery, and one each to the upper and lower articular arteries on the inner side of the knee-joint.

Muscular.—One to each head of the gastrocnemius, to the plantaris, to the soleus, and to the popliteus. The latter gives filaments to the tibia and interosseous membrane, and turns beneath the lower border of the muscle.

Cutaneous.—The tibial or popliteal communicating. It runs between the two heads of the gastrocnemius, pierces the fascia about halfway down the calf, and receives the peroneal communicating nerve from the external popliteal. It then runs in company with the short saphenous vein, along the outer border of the tendo Achillis and below the outer malleolus, to end in the skin of the outer side of the foot and little toe, communicating with the musculocutaneous nerve.

The **posterior tibial nerve** is the continuation of the internal popliteal from the lower margin of the popliteus. It runs down between the superficial and deep layers of muscles and is successively internal, behind, and external to the artery, and divides between the inner ankle and heel into the *two plantar nerves.*

Branches.—*Articular,* to the ankle.

Muscular.—One each to the tibialis posticus, flexor longus digitorum, flexor longus pollicis, and the soleus.

A *cutaneous* branch pierces the internal annular ligament to supply the skin of the heel and back part of the sole.

The **internal plantar nerve** runs beneath the abductor pollicis, then between it and the flexor brevis pollicis, and divides into its digital branches. It corresponds to the median in the hand.

Branches.—*Muscular,* to the abductor pollicis and flexor brevis digitorum.

Cutaneous, to the skin of the sole.

Digital branches as follows: The first, to the inner side of the great toe, supplies the flexor brevis pollicis; the second, to the great and second toes, supplies the first lumbricalis; the third, to the second and third toes, supplies the second lumbricalis; and the fourth, to the third and the inner side of the fourth toe, communicating with the external plantar. Each digital nerve supplies cutaneous and articular branches and terminates as in the hand.

The **external plantar** runs between the flexor accessorius and the flexor brevis digitorum, dividing between the latter and the abductor minimi digiti into a superficial and a deep branch. Before dividing it supplies the flexor accessorius and abductor minimi digiti. It corresponds to the ulnar in the hand.

The *superficial* gives a digital branch to the outer side of the little toe, which supplies its short flexor and sometimes also the interossei of the fourth space, and another digital branch to the adjacent sides of this toe and the fourth.

The *deep* branch dips under the accessorius and flexor muscles, and supplies all the dorsal and plantar interossei except, occasionally, those of the fourth space; it also supplies the outer two lumbricales, the adductor pollicis, and the transversus pedis.

The **external popliteal** or **peroneal** nerve runs between the biceps muscle and outer head of the gastrocnemius, turns round the fibula just below its head and beneath the peroneus longus, and divides into the anterior tibial and the musculocutaneous nerves.

Branches.—*Articular,* with the upper and lower external articular arteries, and occasionally a *recurrent articular* branch, with the recurrent tibial artery, reaches the joint.

Cutaneous, two in number, supply the skin of the outer and back part of the leg; and another, arising from its lower part, the *peroneal communicating,* crosses the outer head of the gastrocnemius and passing obliquely downward joins the popliteal communicating to form the short saphenous nerve.

The **musculocutaneous** nerve runs between the extensor longus digitorum and the peronei, and pierces the fascia at the lower part of the leg, dividing into two branches, *external* and *internal,* for the toes.

Branches.—*Muscular,* to the peroneus longus and brevis; *cutaneous,* to the lower part of the leg.

The terminal branches: Of these, the *internal* runs on the dorsum of the foot and supplies the adjacent sides of the second and third toes and the inner side of the great toe. It communicates with the long saphenous and anterior tibial nerves.

The *external* supplies the fourth toe, together with the contiguous sides of the third and fifth. It communicates with a branch of the short saphenous nerve.

The **anterior tibial** nerve, from between the peroneus longus and fibula, runs along the front of the interosseous membrane with the artery to the ankle, where it divides into an external and an internal branch. It is at first external, then in front, and below again external to the artery.

Branches.—*Muscular,* to the tibialis anticus, extensor longus digitorum, extensor proprius, and the peroneus tertius; *articular,* to ankle; and its terminal branches. Of these—

The *external* runs under the extensor brevis digitorum, and supplies it as well as the neighboring joints.

The *internal* accompanies the dorsal artery of the foot to the first interosseous space, and supplies the skin of the great and second toes, joining a branch of the musculocutaneous. Both these nerves send interosseous branches to the metatarso-phalangeal joints.

THE SYMPATHETIC NERVOUS SYSTEM

The sympathetic nervous system consists of a series of ganglia, cords, and plexuses, with their communicating and distributing nerve fibers. Its nerves supply all the viscera and the coats of the bloodvessels.

There are two principal **gangliated cords**, lying one on each side of the spine from the base of the skull to the coccyx. They consist of a series of ganglia connected by short single or double cords. The number of the ganglia corresponds in general to that of the vertebræ in the several regions, except in the neck, where there are but three.

Below, these cords end on the front of the coccyx by a loop on which is the **ganglion impar**, and above they are connected with the carotid plexus in the carotid canal.

The **ganglia** are *connected with the spinal nerves* by gray and white fibers, the former passing from the ganglia to the spinal nerves, and the latter *vice versa.* The ganglia are also *connected together* by gray and white fibers, the latter being continuous with the fibers of the spinal nerves prolonged to the ganglia.

There are three great **plexuses**, consisting of nerves and ganglia. They are single and lie in front of the spine in the thoracic, abdominal, and pelvic regions, and each is named, from above downward, the cardiac, epigastric, and hypogastric plexus.

THE SYMPATHETIC NERVES OF THE NECK

The **cervical part** consists of three ganglia, named superior, middle, and inferior, on each side.

The **superior ganglion,** opposite the second and third cervical vertebræ, is reddish gray in color, fusiform in shape, and lies on the rectus anticus major behind the internal carotid vessels.

Branches.—An *ascending* branch runs alongside the internal carotid artery, and in the canal separates into an *outer* division, forming the carotid plexus, and an *inner*, forming the cavernous plexus.

The *carotid plexus* lies external to the artery. It sends one or more filaments to the sixth nerve as it lies alongside the artery, and some to the Gasserian ganglion; to the spheno-palatine ganglion it sends the large deep petrosal nerve, which joins the large superficial petrosal to form the Vidian; it also sends the small deep petrosal, which communicates with Jacobson's nerve by joining the tympanic plexus.

The *cavernous plexus,* in the cavernous sinus, lies below and internal to the internal carotid. It sends a branch to the third nerve, one to the fourth, several to the ophthalmic division of the fifth, the sympathetic root to the ophthalmic ganglion and filaments to the pituitary body.

Both these plexuses supply terminal filaments which form plexuses on the ophthalmic and cerebral arteries and sub-branches.

A *descending* branch to the middle cervical ganglion.

External branches to the first four spinal nerves, to the ganglia of the vagus, the petrous ganglion of the glossopharyngeal, and to the hypoglossal.

Three *internal* branches, viz., pharyngeal, laryngeal, and the superior cardiac nerve. The *pharyngeal* runs to the pharynx and unites with the branches of the ninth and tenth cranial, forming the pharyngeal plexus.

The *laryngeal* branch joins the superior and external laryngeal nerves.

The *superior cardiac nerve* descends on the longus colli behind the common carotid sheath, and crosses the inferior thyroid artery and recurrent nerve. It rises from the upper ganglion, and receives filaments from a communicating branch between it and the middle ganglion. On the *right* side it crosses the subclavian, and runs along the innominate artery to join the deep cardiac plexus behind the aorta. It receives many branches from the vagus and sympathetic. The *left* descends along the left carotid to enter the superficial cardiac plexus in front of the aorta.

The *anterior* branches of the superior ganglion pass to the bloodvessels, viz., to the external carotid and its branches—forming gangliated plexuses named lingual, facial, temporal, meningeal, etc. They communicate with the submaxillary and otic ganglia and with the geniculate ganglion of the facial nerve (*external petrosal nerve*).

The **middle** (**thyroid ganglion**) lies in front of the sixth cervical vertebra, on the inferior thyroid artery. It is connected with the superior and inferior ganglia and with the fifth and sixth cervical nerves. It also gives off the *thyroid branches* and *middle cardiac* nerves.

The *thyroid* branches run along the inferior thyroid artery to the gland, and join the recurrent and external laryngeal nerves. On the artery they connect with the upper cardiac nerve.

The *middle cardiac nerve* (deep or great), on the left side, descends between the carotid and subclavian arteries to join the deep cardiac plexus; on the right it runs in front of or behind the subclavian artery, then along the trachea, to join the deep cardiac plexus. In its course it joins the recurrent branch of the vagus and the upper cardiac nerve.

The **inferior cervical ganglion** lies between the transverse process of the seventh cervical vertebra and the neck of the first rib, behind the vertebral artery, and communicates with the seventh and eighth cervical nerves by gray rami communicantes. It sends branches to the middle cervical; one of these forms a loop around the subclavian artery, called the ansa subclavii (Vieussenii), also the first thoracic ganglion (these branches may be derived from the *middle* cervical ganglion), and some along the vertebral artery, forming a plexus. It also sends off the *inferior cardiac nerve.* This descends behind the subclavian artery and along the trachea, and, after communicating with the middle cardiac and recurrent nerve, ends in the deep cardiac plexus.

THE SYMPATHETIC NERVES OF THE THORAX

In the **thoracic portion** ganglia lie in a line along the heads of the ribs, beneath the pleura and in front of the intercostal vessels. They communicate with the spinal nerves. The upper five or six supply the aorta, the vertebræ and their ligaments, and enter into the posterior pulmonary plexus.

The lower six or seven unite to form the splanchnic nerves.

The **large splanchnic** arises from the fifth or sixth to the ninth or tenth, descends obliquely along the spine, and pierces the crus of the diaphragm to end in the semilunar ganglion, sending branches to the renal plexus and suprarenal capsule.

The **lesser splanchnic** arises from the tenth and eleventh, and, piercing the crus, ends in the celiac plexus, communicating with the preceding and the renal plexus.

The **least splanchnic** arises from the last ganglion, and pierces the crus, joining the renal plexus and sending branches to the celiac plexus.

THE SYMPATHETIC NERVES OF THE LUMBAR REGION

In the **lumbar portion** the ganglia lie in front of the spine, along the inner side of the psoas. They communicate with the ganglia above and below, and by two branches with each of the spinal nerves.

Branches. Some cross the aorta to join the aortic plexus; some cross the common iliacs and enter the hypogastric plexus; others supply the vertebræ and their ligaments.

THE SYMPATHETIC NERVES OF THE SACRAL REGION

In the **sacral portion** the ganglia lie internal to the anterior sacral foramina, sending branches to the ganglia above and below, and two branches each to the sacral nerves. The remaining branches join together and send filaments, some to enter the pelvic plexus and others to form a plexus on the middle sacral artery. The two lowest ganglia on each side are joined by a loop over the coccyx, on which is the *ganglion impar.*

THE SYMPATHETIC PLEXUSES

The **cardiac plexus** lies at the base of the heart, and consists of a superficial and a deep part.

The **superficial cardiac plexus** lies between the aorta and the right pulmonary artery. It is formed by the left superior cardiac nerve and the lower cervical cardiac branch of the left vagus, a small ganglion (Wrisberg's) being found at their point of union. It forms a great part of the right coronary plexus, and sends filaments to the anterior pulmonary plexus, and sends branches to the deep cardiac plexus.

The **deep cardiac plexus** lies in front of the trachea at its bifurcation, above the point of division of the pulmonary artery and behind the aorta. It receives all the cardiac branches of the sympathetic, excepting the left superior cardiac; and of the vagus and its recurrent branches, excepting the lower cervical cardiac branch of the left side.

From the left side of the plexus branches pass to the superficial cardiac plexus and to the left coronary plexus. From the right, the branches in part join those from the superficial plexus to form the right coronary plexus; some pass to the left coronary plexus, others to the right auricle. Both sides of the plexus furnish filaments to the anterior pulmonary plexuses.

The *left coronary plexus* surrounds the left coronary artery and its branches, and supplies the cardiac muscle. The *right* surrounds the right coronary artery in a similar way. The former receives its filaments from the deep plexus, the latter from both superficial and deep.

The **epigastric (solar) plexus** is placed in front of the aorta and crura of the diaphragm, behind the stomach, and between the suprarenal bodies. It receives the great splanchnic nerves, and the vagi send branches to it. It consists of a collection of nerves and ganglia, and its branches accompany the vessels to the principal viscera of the abdomen.

The largest of its ganglia are the *semilunar*, one on each side. They lie near the suprarenal bodies, in front of the crura, the right one beneath the inferior vena cava. They receive the great splanchnic nerves. The lower portion of each semilunar ganglion is detached, and is called the **aorticorenal ganglion**.

The **branches** of the solar plexus form **secondary plexuses,** and are the following:

The **phrenic plexus,** on the artery of the same name, to the diaphragm, supplies also the suprarenal capsules. It joins with branches from the phrenic nerve, and at the point of junction on the right side is a small ganglion, the diaphragmatic, on the under side of the diaphragm.

The **suprarenal plexus** receives branches from the phrenic plexus and great splanchnic nerves. At the point where the latter join is a ganglion.

The **renal plexus** receives filaments from the aortic plexus and the small and smallest splanchnics. The branches run along the renal artery, and send filaments to the spermatic plexus and to the inferior cava.

The **spermatic plexus** is derived from the renal and aortic plexuses, and runs on the spermatic vessels. In the female (**ovarian**) it supplies the uterus and ovaries.

The **celiac plexus** surrounds the celiac axis, and divides into the gastric, hepatic, and splenic plexuses, which accompany the corresponding vessels. It receives splanchnic branches; on the left side it receives also filaments from the right vagus.

The **gastric plexus** receives filaments from the vagi.

The **hepatic plexus** receives branches from the left vagus, and sends nerves to the right suprarenal plexus, and forms secondary plexuses, which follow the branches of the hepatic artery.

The **splenic plexus** is reinforced from the left semilunar ganglion and the right vagus.

All the above plexuses run along with the arteries, and subdivide into secondary plexuses, corresponding to the arterial branches, which form complex communications with one another. The same applies to the following:

The **superior mesenteric plexus** is reinforced by a branch from the union of the celiac axis and right vagus.

The **aortic plexus**, on the abdominal aorta, is reinforced by filaments from the solar plexus and lumbar ganglia, renal plexuses and semilunar ganglia. It ends in the hypogastric plexus.

The **inferior mesenteric plexus** arises from the preceding, and runs on the artery, joining superior mesenteric branches and the pelvic plexus.

The **hypogastric plexus** is formed by lateral prolongations from the aortic plexus and lumbar ganglia. It lies between the two common iliac arteries. Below it bifurcates into the two pelvic plexuses.

The **pelvic plexuses (inferior hypogastric)** lie one on each side of the rectum, and in the female, the vagina. They receive filaments from the second, third, and fourth sacral nerves, and where these join the plexus small ganglia are developed. The nerves from the plexus supply all the pelvic viscera, accompanying the branches of the internal iliac artery and forming the following secondary plexuses:

The **hemorrhoidal plexus** joins the superior hemorrhoidal branches (from the inferior mesenteric plexus) to supply the rectum.

The **vesical plexus** contains many spinal nerves, runs with the vesical arteries, and sends nerves along the vas deferens.

The **prostatic plexus** consists of large nerves from the lower part of the pelvic plexus, which supply the prostate, seminal vesicles, and cavernous bodies. These latter are divided into the small and large cavernous, and join the pudic branches. The small pierce the fibrous coat near the root of the penis and end in the erectile tissue. The large (single) runs forward on the dorsum, and supplies the corpora spongiosa and corpora cavernosa.

The **vaginal plexus** runs in the vaginal walls and mucous membrane.

The **uterine plexus** sends some branches along the uterine artery, and others which directly pierce the cervix and lower part of the body. Branches pass also to the ovarian plexus and fundus uteri.

THE ORGANS OF SPECIAL SENSE

THE EYE

The eyeball lies in the fat of the orbit, surrounded by a tunic of fascia, the *capsule of Tenon.* It is composed of segments of two spheres, an anterior smaller and a posterior larger, the junction of the sclerotic and cornea indicating their limits. It measures one inch transversely and vertically, and somewhat less from before backward. Behind it receives the optic nerve, and in front are the eyelids, eyebrows, etc., which comprise the so-called appendages of the eye.

The **appendages of the eye** include the eyebrows, eyelids, conjunctiva, the lacrymal gland and sac, and the nasal duct. The last three belong to the "lacrymal apparatus."

The *eyebrows* (supercilia) are two prominent tracts of integument above the orbit, covered by thick hairs. They are connected with the orbicularis, corrugator supercilii, and occipitofrontalis muscles.

The *lids* (palpebræ) protect the eyeball. Each is composed of thin integument, areolar tissue, muscular fibers, the tarsal cartilage and ligament, Meibomian glands, and conjunctiva; the upper lid, which is also the more movable, contains, in addition, the aponeurosis of the levator palpebræ.

The *lids* are separated, when opened, by a space, the fissura palpebrarum, and are united at the angles (canthi). The outer canthus is sharp, and the inner is more obtuse. At the inner canthus, on each lid, is found the lacrymal tubercle, pierced by the punctum lacrymale, the upper opening of the lacrymal canal.

The *tarsal cartilages* (tarsi) are two plates of dense fibrous tissue, one in each lid. Into the anterior surface of the upper the levator palpebræ is inserted. Each is attached at the inner angle to the tendo oculi or internal tarsal ligament; at the outer angle to the external tarsal ligament, which is inserted into the malar bone.

The *tendo oculi* or palpebrarum is Y-shaped. The stem is attached to the nasal process of the superior maxilla, and each arm to one of the tarsal cartilages.

The *palpebral ligament* is a fibrous membrane attached to the tarsal cartilages and to the corresponding margin of the orbit.

The *Meibomian glands* (sebaceous) lie on the inner surface of the lids, between the tarsal cartilages and the mucous membrane. In the upper lid there are about thirty; in the lower, fewer.

The *lashes* (cilia) are short, thick hairs forming a double row on the free margin of each lid. Above they are longer and more numerous.

The *conjunctiva* is the mucous membrane of the eye. The *palpebral* portion is very thick and vascular, and forms at the inner canthus a fold known as the plica semilunaris. The *ocular* portion is loosely connected to the sclerotic, but over the cornea consists only of the conjunctival epithelium. The line of reflection from the lid on to the eyeball is called the fornix conjunctivæ.

Near the inner canthus there is also a collection of follicles constituting the caruncula lacrymalis, and external to this is the plica semilunaris.

The **lacrymal apparatus** includes the gland, the two canals, the sac, and the nasal duct.

The *gland* is about the size and shape of a small almond, and lies in a depression in the orbital plate of the frontal bone just inside the external angular process. Above it is attached to the periosteum, and below it rests on the eyeball and the upper and outer recti. In front it is closely connected to the upper lid and is covered by conjunctiva. Its ducts, ten or more in number, run beneath the conjunctiva and open separately at the outer part of the fornix.

The *lacrymal canals* commence by small orifices, the puncta, on the margin of each lid, and empty close together into the sac. The upper and longer ascends at first, then runs downward and inward; the lower ones downward, then inward.

The *lacrymal sac* is the upper dilated part of the nasal duct, and lies in a depression formed by the lacrymal and superior maxillary bones; it is invested by an aponeurosis derived from the tendo oculi, and is crossed by the tensor tarsi.

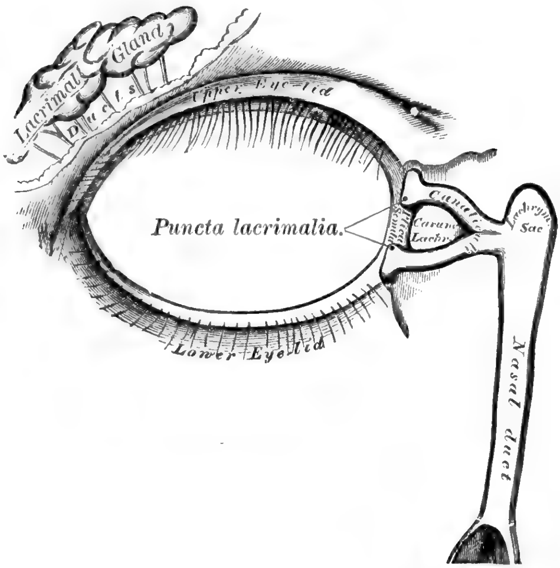
The *nasal duct* is contained in a canal formed by the superior maxilla, lacrymal and inferior turbinated bones, and runs from the lacrymal sac to the inferior meatus. It is lined with a mucous membrane continuous with the conjunctiva, is narrowest in the middle, and at its lower expanded orifice is the valve of Hasner. Its direction is downward, backward, and outward. Its epithelium is ciliated.

The **eyeball** consists of three coats enclosing the refractive media or humors. They are the sclerotic and cornea outside, the retina internally, and the choroid between them.

The **sclerotic coat** is a dense fibrous membrane, white and smooth externally, excepting where it receives the insertion of the recti and obliqui. Internally it is brown, grooved by the ciliary nerves, and united by a connective tissue, the *lamina fusca,* to the choroid beneath. It covers the posterior five-sixths of the eyeball. Behind it receives the optic nerve at a point just internal to the centre, the fibrous sheath of the former being continuous with the sclerotic. Here there is a number of small apertures (lamina cribrosa) for the funiculi of the optic nerve, and outside of these smaller foramina for the passage of vessels.

The **cornea** forms the anterior sixth of the external coat. It is transparent and projecting, and nearly an arc of a true sphere, the anterior surface being convex and the posterior surface concave.

Fig. 66



The lacrymal apparatus. (Gray.)

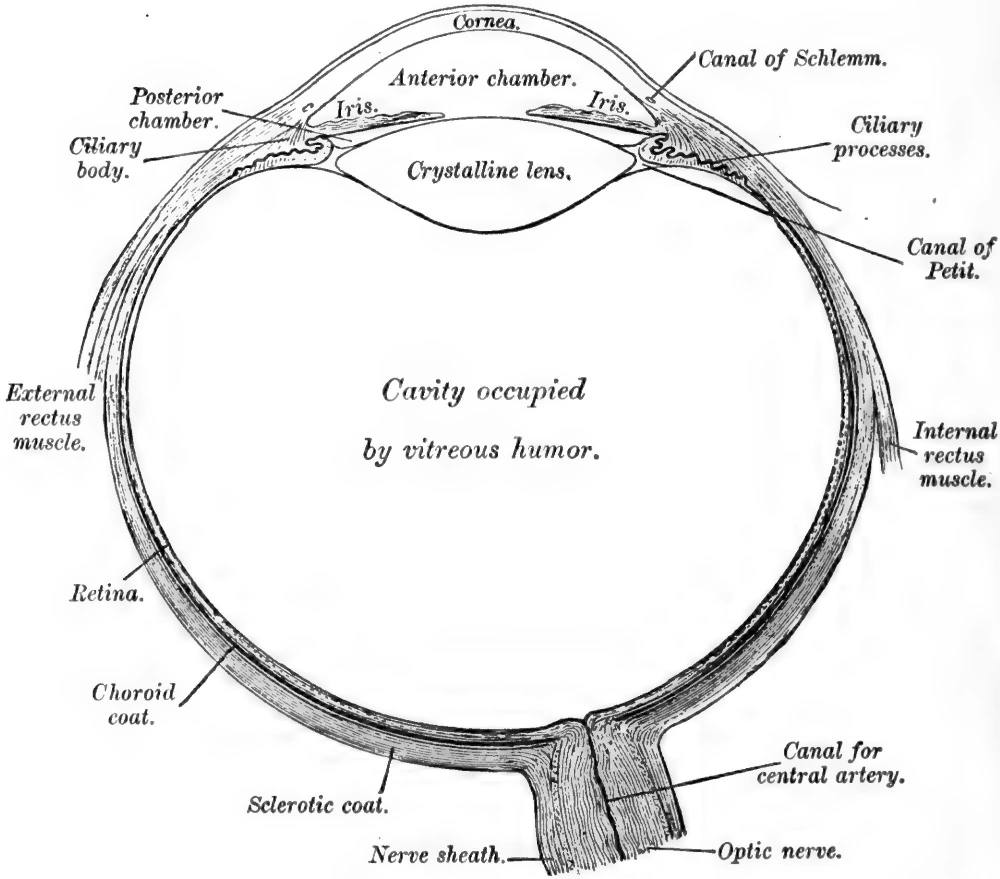
The **choroid** or **intermediate coat** is continued into the **choroid,** prolonged into the iris anteriorly, and forming the ciliary processes.

It is a chocolate-colored vascular structure lying between the sclerotic and retina and investing the posterior five-sixths of the eyeball, blending in front with the iris after forming a number of folds, the ciliary processes. Behind it is pierced by the optic nerve. It is smooth internally, and is connected to the lamina fusca of the sclerotic externally.

The *ciliary processes,* seventy or more in number, consist of a circle of folds or thickenings of the choroid received into pits in the vitreous and suspensory ligament of the lens. They are divided into a larger and a smaller set, the former being about one-tenth inch in length. Their inner surface is covered by the layer of hexagonal pigmented cells of the retina.

The choroid is really a plexus of fine bloodvessels. Externally it presents a membrane, the *lamina suprachoroidea,* between

Fig. 67



A horizontal section of the eyeball. (Allen.)

which and the *lamina fusca* is a lymph-space which communicates with the capsule of Tenon through apertures in the sclerotic.

The *ciliary muscle* is a circular plane of unstriped muscle placed between the choroid and sclerotic at its anterior part.

It consists of circular and radiating fibers. The latter arise near the union of the sclerotic and cornea, and are inserted into the choroid opposite the ciliary processes; the former surround the insertion of the iris.

The *iris* gives to the eye its color. It is a thin, contractile, circular membrane presenting, at about its centre, a circular aperture, the pupil. It is suspended in the aqueous humor behind the cornea and in front of the lens. Its circumference is continuous with the choroid, and, through the *ligamentum pectinatum,* with the cornea. Its posterior surface is covered by dark pigment resembling that of a ripe grape; hence the term "uvea." The edges of the pupillary orifice are in contact with the lens, the size of the pupil varying from $\frac{1}{20}$ to $\frac{1}{3}$ inch across.

The muscle fibers are radiating and circular. The latter form a sphincter for the pupil; the former constitute the dilator muscle.

The arteries are supplied from the long and anterior ciliary. The nerves are branches of the lenticular ganglion and the long ciliary from the nasal branch of the ophthalmic. They form a plexus around the circumference of the iris, and end in the muscular fibers and in a network on the front of the iris. The nerves to the circular fibers come from the motor oculi; those to the radiating, from the sympathetic.

The **retina** is a delicate nervous membrane on which the image of perceived objects is formed. It lies between the choroid and the hyaloid membrane of the vitreous, and is composed of ten layers. Behind, the optic nerve expands into it, and in front it terminates in a dentated margin, the *ora serrata,* at the outer edge of the ciliary processes. It then sends off a thin, non-nervous membrane, the pars ciliaris retinæ, to the tips of the ciliary processes. The inner surface of the retina presents at its centre an elliptical spot about $\frac{1}{20}$ inch across, the *macula lutea.* In the centre of this spot is a depression, the *fovea centralis,* which, on account of the extreme thinness of the retina, shows the pigmentary layer of the choroid, and hence presents the appearance of a foramen. About $\frac{1}{10}$ inch to the inner side of the yellow spot is the *porus opticus,* at which point the optic nerve enters, the nervous matter being heaped up here so as to form the *colliculus.* Passing through nearly the entire thickness of the retina, supporting its layers and binding them together, are the radiating fibers, or fibers of Müller. They form at one extremity the membrana limitans interna, and at the other the externa.

The **vitreous body** is a transparent gelatinous fluid enclosed in a transparent membrane, the *hyaloid,* and fills about four-fifths of the eyeball. In front it is hollowed out to receive the lens and its capsule, being adherent to the back of the latter. In the centre of the vitreous from the entrance of the optic nerve to the back of the lens runs a canal. It contains fluid, is about $\frac{1}{12}$ inch in diameter, and is called the canal of Stilling.

The **crystalline lens** is a solid transparent biconvex body which lies, enclosed in its capsule, in front of the vitreous and behind the iris. The greater convexity is behind, and the lens measures anteroposteriorly $\frac{1}{5}$ inch and transversely $\frac{1}{3}$ inch. It consists of concentric laminæ which are progressively harder from without inward.

The *capsule* is an elastic, transparent, structureless membrane, in contact anteriorly with the iris and held in place by the *suspensory ligament.*

The *suspensory ligament* is a thin, transparent membrane placed between the vitreous humor and the ciliary processes, and presents externally a number of folds which receive those of the ciliary processes. It is really a part of the hyaloid membrane, which runs forward to the front of the margin of the lens. It is also called the zonula of Zinn, and is covered externally by the pars ciliaris retinæ. Between its back part and the lens is a space, the canal of Petit. This canal is bounded in front by the suspensory ligament (zonula of Zinn), behind by the vitreous, and at its base is the capsule of the lens.

The **aqueous humor** is the fluid which fills the space between the suspensory ligament and capsule behind and the cornea in front. That part of this space which lies in front of the iris is called the *anterior chamber;* the part behind the iris is the *posterior chamber.* The latter is really only the small interval between the iris, suspensory ligament, and ciliary processes.

For a more complete description of the minute structure of the eye the reader is referred to the standard books on anatomy and histology.

THE EAR

The ear is divided into the external ear, the middle ear, or tympanum, and the internal ear, or labyrinth.

The **external ear,** the projecting part, or *pinna,* and the *external auditory canal* and *meatus.* The pinna or auricle is ovoid in outline, concave externally, and facing outward and somewhat forward, presenting eminences and depressions to which various names have been given. Thus, the most external ridge is the *helix;* parallel and internal to this is the *antihelix,* a ridge which divides above to enclose the *fossa of the antihelix;* between these two ridges is the *fossa of the helix* (fossa scaphoidea); in front of the antihelix is a deep depression, the *concha,* which presents above and in front the commencement of the helix; in front of the concha is a small process, the *tragus,* which points backward; and behind this is the *antitragus,* a deep notch, the incisura intertragica, separating the two; and lastly, below these is the *lobule.*

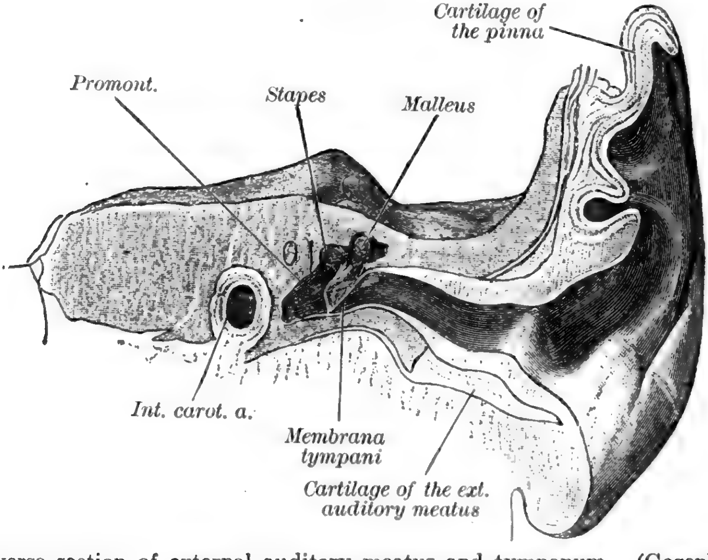
The pinna consists of a plate of yellow fibrocartilage covered by skin and some adipose tissue. It enters also into the formation of the external meatus, being attached to the external auditory meatus of the temporal bone. The lobule contains only fat and strong fibrous tissue.

The *external auditory canal* is $1\frac{1}{4}$ inches long, and runs from the concha to the membrana tympani. It is directed obliquely forward, inward, and downward, and presents an eminence in the floor of the osseous part, which makes the direction of the canal at first upward, then downward. It is narrowest at its middle. Its floor is longer than the roof, on account of the oblique position of the membrana tympani. It opens externally by means of the external auditory meatus.

The **middle ear,** or **tympanum,** is a cavity in the petrous portion of the temporal bone, extending from the membrana tympani to the outer wall of the labyrinth. Its width varies from $\frac{1}{12}$ to $\frac{1}{6}$ inch. It contains the ossicles of the ear, with their ligaments and muscles, and certain nerves. It is filled with air, and communicates by means of the Eustachian tube with the pharynx.

The *roof* of the tympanum is formed of very thin bone, which separates it from the cranial cavity. The *floor* is also of bone and separates it from the jugular fossa beneath and the carotid canal in front. The *outer wall* is formed by the membrana tympani and the ring of bone into which this is inserted, and presents, just in front of the bony ring, the Glaserian fissure, which lodges the processus gracilis of the malleus and transmits some tympanic vessels; at the back part, the iter posterius for the entrance of the chorda tympani, and the iter anterius, anteriorly, for its exit. The former leads to the aquæductus Fallopii, the latter to the canal of Huguier.

Fig. 68

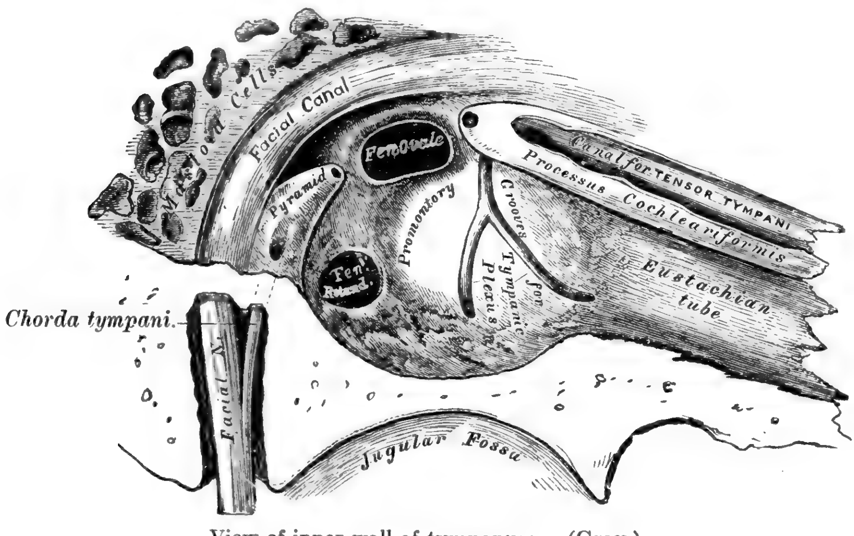


Transverse section of external auditory meatus and tympanum. (Gegenbaur.)

The *membrana tympani* is a thin membrane inserted into a ring of bone at the bottom of the external canal, which is grooved for its reception. It is ovoid in form and directed obliquely downward and inward. On its inner surface is the handle of the malleus, which extends from about the middle of its roof to a little below its centre, covered by mucous membrane where it is attached. This process draws the membrane inward, making its outer surface concave and its inner convex. Externally, the membrane is covered by skin, continuous with that of the meatus; internally, with mucous membrane, continuous with that of the tympanum; and between these two is a fibrous layer, some of its fibers radiating from the handle of the malleus, others being circular and placed near the circumference. At the anterosuperior part of the membrane is a notch in the bony ring, the notch of Rivini. That part of the membrane occupying it is called the *membrana flaccida.*

The *inner wall* of the tympanum is vertical and uneven. It presents the following: (*a*) The *fenestra ovalis,* leading into the vestibule, and occupied in the recent state by the base of the stapes and its annular ligament. (*b*) *Fenestra rotunda,* in a conical fossa leading into the cochlea, a rounded eminence. (*c*) The *promontory,* separating it from the preceding. It is closed, in the recent state, by the *membrana tympani*

Fig. 69



View of inner wall of tympanum. (Gray.)

secundaria. This is composed of three layers, and is concave toward the tympanum. The middle layer is fibrous, the outer and inner being continuous with the lining membrane of the two cavities. The promontory indicates the first turn of the cochlea, and is grooved for branches of the tympanic plexus. (*d*) The *ridge* of the *aquæductus Fallopii,* running above the fenestra ovalis and descending on the posterior wall. (*e*) The *pyramid,* a hollow eminence containing the stapedius, the tendon of the muscle escaping through a foramen in its summit. A minute canal containing the nerve to this muscle runs from the aquæductus Fallopii to the cavity of the pyramid.

The *posterior wall* of the tympanum presents above one large and several small apertures leading to the *mastoid cells.*

The *anterior extremity* opens into two canals separated by a process of bone, the *processus cochleariformis.* The upper of these canals is the smaller and transmits the tensor tympani; the lower contains the Eustachian tube, and osteocartilaginous passage $1\frac{1}{2}$ inches long, leading to the pharynx. Both of these canals run in a direction downward, forward, and inward.

The osseous part of the Eustachian tube is $\frac{1}{2}$ inch long, and to its lower end is attached the triangular piece of fibrocartilage forming the remainder of the tube. The edges of the cartilage are not in contact, but are joined by fibrous tissue. The tube is wide at its lower extremity, and opens at the upper and lateral part of the pharynx, above the hard palate and behind the lower turbinated bone. It is lined by epithelium continuous with that of the pharynx.

The **ossicula** are three small movable bones, named the malleus, incus, and stapes. The first is attached to the membrana tympani; the second is between the other two; the last named is attached to the fenestra ovalis.

The **malleus** (a hammer) consists of a head, neck, and three processes, viz., the *processus gracilis,* the *processus brevis,* and the *manubrium.* The *head* articulates with the incus. The *neck* is below it, and rests on a *prominence* which is connected with the three processes. The *manubrium* tapers to its extremity, which is flattened, and it is connected with the membrana tympani. The tensor tympani is attached to its inner side near its upper end, and from its root springs the *processus brevis.* The *processus gracilis* is long and slender, and is connected by bone and fibrous tissue with the Glaserian fissure.

The **incus** (an anvil) has a *body* and *two processes.* The *body* presents a saddle-shaped articular surface for the malleus; the *short process* is conical, looks backward, and is attached to the opening which leads to the mastoid cells; the *long process* descends behind the manubrium of the malleus, to end in the *os orbiculare,* or lenticular process, which articulates with the head of the stapes.

The **stapes** (a stirrup) presents a *head,* which articulates with the os orbiculare; a *neck,* to which is attached the stapedius muscle; and *two crura,* diverging from the neck, and connected at their extremities by the *base,* which fills up the fenestra ovalis.

The articulations *between* the several bones are provided with synovial membranes; their surfaces are covered with cartilage and are connected by capsular ligaments. The following ligaments connect the bones with the walls of the tympanum:

The *anterior ligament* of the *malleus* is attached to the neck of the malleus at one end, and at the other to the anterior wall of the tympanum close to the Glaserian fissure, and its *suspensory ligament* runs from the roof of the tympanum to the head of the bone. An *external ligament* runs from the notch of Rivini to the body and lesser process, and the *accessory anterior ligament* is the thickened front portion of the sheath of the tensor tympani, which runs from the anterior wall to the manubrium and neck. An *inferior ligament* runs from the end of the handle to the outer wall of the tympanum.

The base of the stapes is fixed to the margin of the fenestra ovalis by an *annular ligament.*

The incus is provided with a *posterior ligament,* running from the short process to the posterior wall, and a *suspensory ligament,* from the roof of the tympanum to the upper part of the bone near its articulation with the malleus.

The Muscles of the Middle Ear.—The **tensor tympani** runs in the canal previously mentioned. Arising from the under surface of the petrous portion, the cartilage of the Eustachian tube, and the margins of its own canal, its tendon is reflected over the processus cochleariformis and is inserted into the handle of the malleus near its root. It pulls on the malleus, thus drawing inward and making tense the membrana tympani. Its *nerve* comes from the otic ganglion.

The **stapedius** arises from the sides of its containing cavity within the pyramid, and, emerging from the apex, is inserted into the neck of the stapes. It draws the head of the stapes backward, thus pressing the base against the fenestra ovalis and compressing the contents of the vestibule. Its *nerve* is the tympanic branch of the facial.

The **mucous membrane of the tympanum** is pale and thin and its epithelium ciliated. It invests the contents of the cavity, the inner surface of the membrana, and covers the fenestra rotunda. It is continuous with that of the mastoid cells, Eustachian tube, and pharynx.

The **tympanic arteries** come from the internal maxillary, the stylomastoid branch of the posterior auricular, the petrosal branch of the middle meningeal, the Eustachian branch of the ascending pharyngeal, and from the internal carotid. The veins reach the internal jugular by means of the middle meningeal and pharyngeal veins.

The **nerves of the tympanum** are the *muscular,* already mentioned; the *nerves* to the *mucous membrane* from the tympanic plexus; the *communicating,* viz., between Jacobson's nerve, the sympathetic, and branches of the geniculate ganglion of the seventh; and the *chorda tympani.*

Jacobson's nerve (tympanic branch of the ninth) enters the tympanum in the floor and passes to the promontory. It forms the tympanic plexus, from which are supplied the fenestræ, Eustachian tube, and lining membrane, and sends off two communicating branches—one to the carotid plexus, one to the great superficial petrosal. It then receives a filament from the geniculate ganglion of the facial, and proceeds to join the otic ganglion as the lesser superficial petrosal nerve.

The *chorda tympani* arises from the facial near the stylomastoid foramen, enters at the base of the pyramid, crosses the tympanum between the long process of incus and handle of malleus, and runs through the iter chordæ anterius to the canal of Huguier.

The **internal ear** is the essential part of the hearing apparatus, since here the auditory nerve is distributed. It is contained in a cavity in the petrous bone, and is made up of the osseous labyrinth and of the membranous labyrinths.

The **osseous labyrinth** contains the *membranous* labyrinth, and is divided into three parts: the vestibule, semicircular canals, and cochlea. It communicates in the dry state with the tympanum by means of the fenestræ. Between the osseous and membranous labyrinth is a space occupied by a clear fluid, the perilymph, and within the membranous labyrinth is the endolymph.

The **vestibule** is the central cavity lying between the cochlea in front and the semicircular canal behind, the tympanum being external. Its *outer* or tympanic *wall* presents the *fenestra ovalis.*

Its *inner wall* has in front a depression, the *fovea hemispherica,* pierced by several minute holes for the auditory filaments, and, behind this, a ridge, the *crista vestibuli.* Behind this ridge is the opening of the *aquæductus vestibuli.* In the *roof* is a depression, the *fovea hemielliptica.*

Behind, the vestibule presents five foramina leading into the semicircular canals, and *in front* a larger foramen leading into the scala vestibuli of the cochlea.

The **semicircular canals** are three bony tubes of unequal length lying above and behind the vestibule, each forming about two-thirds of a circle. Their general diameter is $\frac{1}{20}$ inch, but at one end is a dilatation, the ampulla, $\frac{1}{10}$ inch in diameter. They empty into the vestibule by five apertures, in one of which two tubes join.

The *superior* is vertical and is set transversely, forming an eminence seen on the upper surface of the petrous bone. The ampulla of this tube opens into the upper part of the vestibule, the other end opening by a foramen into the back part, in common with the posterior canal.

The *posterior* is also vertical, but is set anteroposteriorly and is longer than the others, its ampulla being at the postero-inferior part of the vestibule, the other extremity joining with the preceding canal, as described.

The *external* is horizontal and the shortest, its ampulla being at the outer part, above the fenestra ovalis, and the other end at the upper and back part of the vestibule.

The **cochlea** resembles a snail shell. Its apex looks forward and outward, and its base toward the internal auditory meatus. Within is a centre piece, the *modiolus,* or *columella,* around which the canal runs spirally for two and a half turns.

Within the canal, and attached to the modiolus, is the *lamina spiralis.* This plate of bone partially divides the spiral canal into two compartments, or scalæ, the division being completed by a membrane (see below) which reaches the outer wall of the cochlea. The upper scala is known as the *scala vestibuli;* the lower is the *scala tympani.*

The *modiolus,* or columella, the centre piece of the cochlea, runs from base to apex. It is conical in form, the base corresponding to that of the cochlea, and is pierced by foramina for the cochlea branches of the auditory nerve and for the vessels which pass to the lamina and spiral canal. One of these, larger than the rest, is the opening of the *canalis modioli centralis.* Diminishing gradually in size, the modiolus terminates above in a bony process, the *infundibulum,* which blends with the cupola or last half turn of the spiral canal. Here the two scalæ communicate by a small opening, the *helicotrema.* Around the modiolus, along the attachment of the lamina spiralis, is the *spiral canal* of the modiolus, containing a gangliated portion of the cochlear nerve, the ganglion spirale.

The *spiral canal* is $1\frac{1}{2}$ inches long and $\frac{1}{10}$ inch in diameter at its widest part, which is below. The scala vestibuli communicates with the vestibule by the foramen above mentioned, and a part of it, marked off by a membrane, is called the scala media (see below). The *scala tympani* commences at the fenestra rotunda, and close to its commencement is the opening of the *aquæductus cochleæ,* by which it communicates with the subarachnoid space, and in which there is transmitted a small vein to the internal jugular. The *spiral lamina* ends above in a hook-like process, the *hamulus,* which partly bounds the helicotrema.

The **membranous labyrinth** is contained within the osseous labyrinth, having a similar form, though smaller and separated from it by the perilymph. It contains the endolymph and receives the distribution of the auditory nerve. In the vestibule it consists of the utricle and the saccule.

The *utricle* is in the upper and back part, its cavity communicating by five apertures with the membranous semicircular canals. It is in contact with the fovea hemielliptica.

The *saccule* is in the fovea hemispherica, and communicates with the utricle by means of a small tube which passes into the aquæductus vestibuli, and there joins a canal (*saccus endolymphaticus*), which canal is prolonged from the utricle and ends in a blind extremity; and with the scala media by means of the *canalis reuniens.*

The *membranous semicircular canals* are similar in shape to but are only from one-fifth to one-third the diameter of the bony canals; the ampullæ, however, are relatively large. Two small masses of calcium carbonate are found in the utricle and saccule. They are called the otoliths.

In the cochlea the membranous labyrinth is represented by the *scala media* and the parts therein, which are formed as follows:

Along the edge of the spiral lamina the periosteum on its upper surface is raised up like a C to form the *limbus laminæ* *spiralis*. Thus there is a groove (the sulcus spiralis), the upper and lower lips of this sulcus being called respectively the labium vestibulare and tympanicum. From the latter the *membrana basilaris* extends to the outer wall, along the latter attachment forming the ligamentum spirale. Above the limbus to the outer wall stretches another membrane, *Reissner's*. The space below the osseous lamina and the membrana basilaris is the scala tympani; above the membrane of Reissner is the scala vestibuli; and that space bounded by the two membranes and the outer wall of the cochlea is known as the *scala media*, or canal of the cochlea, which ends at the apex of the cochlea in a blind pointed extremity, and opens below into the saccule, as described above. Between the two membranes mentioned a third stretches across in the scala media to the outer wall. This is called the membrane of Corti, or *membrana tectoria*. Between the membrana basilaris and the last-named membrane is a space which contains the organ of Corti.

The *organ of Corti* lies on the basilar membrane. The central part is composed of two rows of peculiarly shaped cells called the rods of Corti, outer and inner. These rods meet above by their extremities, and enclose an angular tunnel between them and the basilar membrane, the *zona arcuata*. The inner rods run close to the labium tympanicum, and along their inner side is a series of epithelioid cells continuous with the cubical epithelium of the sulcus spiralis. These present a row of short, stiff hairs, forming a sort of brush. External to the outer rods are several rows of similar cells. These are called the outer and inner hair cells.

The *reticular lamina* is a delicate structure composed of small segments called phalanges arranged side by side and separated by holes, through which the hairs of the outer hair cells project. The whole organ thus described is covered by the membrane of Corti (membrana tectoria).

The *arteries* of the internal ear are the auditory branch of the basilar, the stylomastoid branch of the posterior auricular, and branches occasionally from the occipital. The first named divides into a cochlear and a vestibular branch.

The *auditory nerve* divides at the bottom of the internal auditory meatus into a *superior* and an *inferior* branch. The former divides into branches, which are distributed to the utricle and to the ampullæ of the superior and external semicircular canals; the latter sends branches to the saccule, to the ampulla of the posterior canal, and to the cochlea.

The cochlear branch sends its filaments through the canals of the modiolus, and these form the ganglion spirale. This ganglion sends other filaments to the sulcus spirale and organ of Corti.

THE NOSE

The nose is the organ of smell, and consists of an *external* part, the nose, and an *internal*, the nasal fossæ.

The *nose* is pyramidal, and is formed by the nasal bones and nasal processes of the superior maxillary bones, and of five cartilages, viz., the two upper and the two lower lateral cartilages, and the cartilage of the septum. The two openings, the anterior nares, are directed downward, and just inside of them are some short, stiff hairs, the vibrissæ. The bones and cartilages are covered by skin on the outer side and by mucous membrane on the inner. Between the anterior nares is a fold of skin, the *columna nasi*, which continues the septum. The two lateral parts join in front to form the dorsum and this ends below in the rounded lobe of the nose.

The *upper lateral cartilages* lie one on each side, below the nasal bones, and are triangular in form. The anterior margin joins its fellow above and the edge of the cartilage of the septum below. The inferior edge joins the lower lateral cartilage by means of fibrous tissue, and the posterior edge the nasal and superior maxillary bones.

The *lower lateral cartilages* are thin, and are curved so as to form the front and both walls of the nostrils. Behind it is attached to the superior maxilla, above to the upper cartilage. Between it and the former several smaller cartilages may be seen. It also joins a small part of the cartilage of the septum. In front it joins its fellow to form the tip of the nose.

The *cartilage of the septum* is quadrilateral, and thinner at the centre than at its borders. It forms the anterior part of the septum, and is joined superiorly to the nasal bones, and to the upper and lower lateral cartilages by its anterior margin. Its posterior margin is attached to the front of the perpendicular plate of the ethmoid, and its lower margin to a groove on the vomer and the ridge between the superior maxillæ.

The **nasal fossæ** (for the osseous part, see *Bones*) open in front by the anterior nares, and into the pharynx behind by the posterior nares. The mucous membrane is called the pituitary, or Schneiderian membrane, and is attached directly to the periosteum or perichondrium. It is continuous with that of the pharynx, conjunctiva, tympanum, and mastoid cells, antrum of Highmore, and with that of the different canals which connect these parts.

The epithelium is squamous near the nostril, columnar where the olfactory nerves are distributed, and columnar and ciliated elsewhere.

The nasal fossæ in the recent state present a different appearance from that seen in the skeleton. They are narrowed, and their component parts appear thicker, their turbinated bones being very prominent. The apertures of the various foramina are narrowed, or even closed, by the lining membrane.

The arteries of the nasal fossæ are the anterior and posterior ethmoidal from the ophthalmic, supplying the ethmoidal cells and frontal sinuses and roof of the nose; the sphenopalatine from the internal maxillary, to the mucous membrane covering the spongy bones, meatuses, and septum; the inferior artery of the septum, from the superior coronary of the facial, and the infraorbital and alveolar branches of the internal maxillary, which supply the lining membrane of the antrum.

The *veins* empty into the ophthalmic and facial, and through the foramen cecum communicate with the cranial sinuses.

The *nerves* are the olfactory filaments distributed to the upper third of the septum and the surfaces of the superior and middle turbinated bone (these filaments do not reach the middle or inferior meatus), the nasal branch of the ophthalmic, the anterior dental of the superior maxillary, the Vidian, nasopalatine, anterior palatine and nasal branches of the sphenopalatine ganglion.

The lymphatics from the external surface drain into the submaxillary and those from the fossæ into the retropharyngeal nodes.

QUESTIONS ON NEUROLOGY

THE CEREBROSPINAL AXIS

What are the enlargements of the cord? To what are these enlargements due?

Roughly speaking, what form does the gray matter of the cord take?

Name the fissures and columns of the cord.

What are the membranes of the cord and brain?

What is the lowest part of the cord called and how low does it extend?

What are the peduncles of the cerebellum?

Name the main lobes of the cerebellum.

Name in order the lobules and interlobular fissures of the upper surface of the cerebellar worm and hemispheres.

Describe the fourth ventricle, giving its location, boundaries, roof, and the markings of its floor.

What are the nuclei of the optic thalami?

Describe the fissures on the convex surface of each hemisphere, giving the names of the lobes thus divided off.

Describe the fissures and lobes of the median surface.

What is the corpus callosum?

Where is the island of Reil?

Describe the lateral ventricles.

Describe the hippocampus major.

THE PERIPHERAL NERVE SYSTEM

Give in order the names of the twelve cranial nerves.

Tell how each of the cranial nerves makes its exit from the skull.

Describe the optic chiasm.

What muscles does the third nerve supply?

What are the three branches of the ophthalmic division of the fifth cranial nerve?

Why is the sixth cranial called abducens?

Where does the facial nerve enter the skull? Where does it come out?

What are the main divisions of the facial nerve?

Describe precisely the course and branches of the pneumogastrics.

How do the right and left recurrent laryngeal nerves differ in origin?

Where do you look in the neck for the recurrent laryngeals?

What muscle does the spinal accessory often pass through?

What muscles does the spinal accessory supply in part?

Describe the course and relations of the hypoglossal.

What muscles does the hypoglossal supply?

Where and how is the phrenic nerve formed?

Is the phrenic in front of or behind the root of the lung?

Draw the plan of the brachial plexus.

How and where is the median nerve formed?

Give the course and relations of the median nerve.

How may the median nerve be located opposite the wrist?

Name the digital branches of the median nerve.

What muscles of the hand does the median nerve supply?

What nerve supplies all the other muscles of the hand?
From what cord does the musculospiral nerve come?
How and where does the musculospiral nerve end below?
What does the radial nerve supply?
How does the posterior interosseous nerve get to a posterior position?
What are the muscular relations of the ulnar nerve in the forearm, and what muscles does it supply there?
Between what muscles is the anterior crural nerve just below Poupart's ligament?
What separates the anterior crural nerve from the common femoral artery?
What structures pass between the anterior and posterior groups of the branches of the anterior crural nerve?
What relation does the external cutaneous nerve bear to the sartorius muscle just after leaving the abdominal cavity?
What structure separates the branches of the obturator nerve?
Where does the obturator nerve leave the pelvis?
To which side of the great sciatic nerve is the small sciatic?
Upon what muscles does the great sciatic nerve lie?
Into what does the great sciatic divide?
Between what muscles does the peroneal nerve lie, opposite the knee-joint?
Where is the peroneal nerve subcutaneous, and where does it divide?
What various relations does the anterior tibial nerve bear to the anterior tibial artery?
Where does the anterior tibial nerve terminate?
At what point does the popliteal nerve become the posterior tibial?
What are the articular branches of the popliteal and peroneal nerves, and what vessels do they accompany?
Of what nerve are the internal and external plantar nerves branches, and to what nerves of the hand do they very closely correspond?

THE SYMPATHETIC NERVE SYSTEM

Is the sympathetic system directly connected with the cerebrospinal system?
What are the principal trunks of the sympathetic system?

THE ORGANS OF SPECIAL SENSE

Describe the eyeball
What and where are the Meibomian glands?
Describe the lachrymal apparatus
What do the chambers of the eye contain?
Just where is the lens, and what holds it in place?
Locate and describe the tympanum!
Describe the Eustachian tube.
Describe the nasal fossæ.

PART VI

SPLANCHNOLOGY, OR THE ANATOMY OF THE VISCERA

THE ORGANS OF RESPIRATION

THE LARYNX

The larynx is the **organ of the voice,** and is placed at the upper and forepart of the neck, between the trachea and base of the tongue.

Relations.—It has on each side of it the great vessels, and behind it the pharynx. In front are the pretracheal portion of the cervical fascia and the upper end of the thyroid gland, and on each side the sternohyoid and thyroid and the thyrohyoid muscles. It consists of various cartilages held together by ligaments, and is lined internally by mucous membrane.

The **cartilages** are nine: Three pairs, the arytenoid, cornicula laryngis, and cuneiform; and three single, the thyroid, cricoid, and epiglottis.

The **thyroid cartilage** is the largest, and consists of two lateral parts or alæ uniting in front to form the projection of the pomum Adami. This is subcutaneous, more distinct above and in the male. Each ala is quadrilateral, and presents externally a tubercle from which a ridge descends obliquely forward. This ridge gives attachment to the sternothyroid and thyrohyoid, and the surface behind it to the inferior constrictor muscle. Internally it is smooth, and in the angle the epiglottis, true and false vocal cords, and the thyroarytenoid and thyroepiglottidean muscles are attached. The upper border is concavoconvex, and in front is notched over the pomum Adami, giving attachment throughout to the thyrohyoid membrane. The lower border is joined to the cricoid cartilage by the middle portion of the cricothyroid membrane; and on either side, affords attachment to the cricothyroid muscle. The posterior borders end in the *upper* and *lower cornua;* to the upper are attached the lateral thyrohyoid ligaments, and the lower, which are shorter and thicker, present internally a facet for articulation with the side of the cricoid cartilage. The stylopharyngeus and palatopharyngeus is attached also to the posterior border.

The **cricoid cartilage** resembles a signet ring, is narrow in front, and gives attachment to the cricothyroid muscle, and behind it to some of the fibers of the inferior constrictor. It is broad behind, with a vertical ridge for the attachment of the longitudinal fibers of the esophagus, separating two hollows for the cricoarytenoideus posticus, and presents at about the middle of the lateral surface a prominence on each side which articulates with the corresponding inferior cornu of the thyroid cartilage. The lower border is joined to the upper ring of the trachea; the upper border gives attachment in front and laterally to the cricothyroid membrane and the lateral cricoarytenoideus muscle. Behind, at each end of its upper border, is an oval surface for the corresponding arytenoid cartilage, with a notch between. The inner surface is smooth and lined with mucous membrane.

The **arytenoid cartilages** are pyramidal in form, presenting three surfaces, an apex and base, and rest by their bases on the highest part of the upper border of the cricoid cartilage behind, their curved apices approximating. To the posterior surface is attached the transverse portion of the arytenoid muscle. The anterolateral surface is somewhat convex and rough. From the colliculus, near the apex, starts a ridge (crista arcuata) which passes backward then forward and downward into a sharp pointed process, the vocal process. The latter separates a deep depression above, the fovea triangularis, from a broader and shallower depression below, the fovea oblongata. To a small tubercle just above the base, on the anterior border, is attached the origin of ligament of the false vocal cord, the superior thyroarytenoid ligament. To the outer part of the ridge, as well as the surface above and below, is attached the thyroarytenoid muscle.

The **cornicula laryngis** (cartilages of Santorini) are two small, cervical nodules, of yellow elastic tissue, which articulate with the summits of the arytenoid cartilages and serve to prolong them backward and inward. They are lodged in the arytenoepiglottic fold.

The **cuneiform cartilages** (Wrisberg's) are two small, yellow bodies of elastic cartilage, which stretch between the arytenoid cartilage and the epiglottis. They are situated in the aryteno-epiglottic fold.

The **epiglottis** is a fibrocartilaginous lamella, shaped like a leaf, lying behind the tongue and in front of the upper orifice of the larynx. Above it is broad, below narrow and prolonged to the notch above the pomum Adami by the thyroepiglottic ligament, or rather, to the angular interval just below the notch, and is attached to the upper border of the body of the hyoid bone by the hyoepiglottic ligament. Laterally are attached the arytenoepiglottic folds of mucous membrane extending back to the apices of the corresponding arytenoids. They contain areolar tissue and a few muscular fibers. The anterior surface is connected with the tongue by the lateral and median glossoepiglottic folds. The posterior surface is concave transversely, convex longitudinally.

The **ligaments of the larynx** are extrinsic and intrinsic. The former connect it to the hyoid bone; the latter connect its parts together.

The **extrinsic ligaments** are the middle thyrohyoid ligament, the two lateral thyrohyoid ligaments, and the hyoepiglottic ligament.

The *middle thyrohyoid ligament* is a fibroelastic structure attached to the entire border of the *notch* of the thyroid cartilage and to the upper border of the posterior surface of the body of the hyoid bone. The *lateral thyrohyoid ligaments* run between the upper cornua of the thyroid and the greater cornua of the hyoid bone. They sometimes enclose the cartilago triticea, a small cartilaginous nodule occasionally ossified. The *hyo-epiglottic* ligament runs from the front of the epiglottis near its apex to the upper border of the body of the hyoid bone. The middle and lateral thyrohyoid ligaments are thickened portions of the thyrohyoid membrane, due to the contained elastic fibers. The cricotracheal ligament connects the cricoid cartilage to the first ring of the trachea. It resembles the fibrous membrane which connects the cartilaginous rings of the trachea.

The **intrinsic ligaments** connecting the thyroid and cricoid cartilages are the cricothyroid membrane, two capsular ligaments. The cricothyroid ligament is of yellow elastic tissue, triangular, and consists of a central thicker portion connecting the adjacent borders of the two cartilages, and two lateral portions running from the upper border of the cricoid to be continuous with the inferior thyroarytenoid ligaments (*true vocal cords*). They extend from the vocal processes of the arytenoid cartilages to the receding angle of the thyroid cartilage near its centre. The lateral portions of the membrane are lined internally by mucous membrane, and are separated from the thyroid cartilage by the cricoarytenoideus lateralis and thyroarytenoideus muscles. In the subcutaneous interval there is a sort of plexus from the junction of the two cricothyroid arteries. The lower cornua of the thyroid are connected with the sides of the cricoid by two ligamentous capsules each lined by a synovial membrane.

The cricoid and arytenoid cartilages are connected by loose capsular ligaments lined by synovial membranes, and by a posterior cricoarytenoid ligament running from the cricoid to the inner and back part of the base of the arytenoid. The movements between the inferior cornu of the thyroid and the cricoid cartilage on either side is a diarthrodial one, and permits of rotary and gliding movements. The movements between the arytenoid cartilages and the cricoid is also a diarthrodial one—gliding and rotary.

The **interior of the larynx** (cavum laryngis) is divided into an upper and a lower part by the rima glottidis. The upper opens into the pharynx by the *upper aperture* of the larynx, between which and the rima glottidis are the ventricles and their saccules and the false vocal cords. The lower aperture is continuous with the trachea.

The *superior aperture* is cordiform in shape, widest in front and narrow behind. In front it is bounded by the epiglottis, behind by the arytenoid cartilages (together with the fold of mucous membrane between them) and cornicula, and laterally by the arytenoepiglottic folds.

The rima glottidis is the space between the true vocal cords and the bases of the arytenoid cartilages. It is somewhat less than 1 inch long, and according to its degree of dilatation, from $\frac{1}{3}$ to $\frac{1}{2}$ inch wide. In easy respiration its form is triangular, with the base posterior, and when fully dilated it is lozenge-shaped.

The **superior** or **false vocal cords** are two mucous folds, each enclosing the corresponding superior thyroarytenoid ligament. This latter is a thin band running between the angle of the thyroid and the anteroexternal surface of the arytenoid cartilage.

The **inferior** or **true vocal cords** are two strong bands, the inferior thyroarytenoid ligaments, covered by mucous membrane and attached to the depression between the alæ of the thyroid cartilage in front and the anterior angle of the base (vocal process) of the arytenoid cartilages behind. Below, each is continuous with the lateral part of the cricothyroid ligament or membrane. Part of the thyroarytenoidei is external and parallel to them.

The **ventricles of the larynx** lie one on each side, between the upper and lower vocal cords, bounded externally by the thyro-arytenoidei. At the front a narrow opening leads into a blind pouch, the laryngeal saccule.

The **saccule of the larynx** is a space on each side, between the false vocal cord and the inner surface of the thyroid cartilage, reaching upward as high as the upper border of that cartilage, and its mucous membrane presents the orifices of sixty or seventy glands. This space has a fibrous capsule. Its laryngeal surface is covered by the inferior arytenoepiglottic muscle, or compressor sacculi laryngis, and its external surface by the thyroarytenoideus and thyroepiglottic muscles.

The muscles of the larynx are divided into extrinsic and intrinsic—the former will be found under the muscle system (p. 159). The latter are:

The *cricothyroid* arises from the front part and sides of the cricoid cartilage, and is inserted into the lower border of the thyroid cartilage and the front of its lower cornu. Separating the inner borders of these two muscles is the central part of the cricothyroid membrane. The action of the two muscles is to approximate the cricoid to the thyroid and thus tense the vocal cords. The nerve supply is from the superior laryngeal.

The *thyroarytenoid* is divided into two parts, outer and inner. It arises in front from the angle of the thyroid at its lower part, and its inner part is inserted into the vocal process and outer surface of the arytenoid cartilage; its outer part, into the outer border and muscular process of the same cartilage, above the internal part. The internal part is adherent and parallel to the true vocal cord; the outer is external to the sacculus laryngis. Their action is to advance the arytenoid cartilages and thus relax the vocal cords. The nerve comes from the inferior laryngeal.

The *thyroepiglotticus* muscle consists of a considerable number of the fibers of the thyroarytenoideus prolonged into the arytenoepiglottic fold, where some of them become lost, others pass on to the margin of the epiglottis.

The *posterior cricoarytenoid* arises from the broad depression occupying each lateral half of the posterior surface of the cricoid cartilage; its fibers pass upward and outward, converging to be inserted into the outer angle (muscular process) of the base of the arytenoid cartilage. The upper fibers are nearly **horizontal,** the middle, oblique, and the lower almost vertical.

The *lateral cricoarytenoid* arises from the upper border of the side of the cricoid cartilage, and is inserted into the muscular process of the arytenoid cartilage in front of the posterior cricoarytenoid muscle.

The *arytenoid* is a single muscle occupying the posterior concave surface of the arytenoid cartilage, and is inserted into the corresponding parts of the opposite cartilage. It consists of an oblique and transverse set of fibers, the former arranged like the limbs of the letter X, the latter fibers pass transversely across. A few of the oblique fibers are continued around the outer margin of the cartilage, and blend with the thyroarytenoid muscle in the arytenoepiglottic fold, and are called the aryepiglotticus muscle.

Actions of the intrinsic muscles: (1) Those which open and close the glottis. (2) Those which regulate the degree of tension of the vocal cords.

1. The two posterior cricoarytenoids open the glottis; and the arytenoid and the two lateral cricoarytenoids close it.

2. The two cricothyroids regulate the tension of the vocal cords, and elongate them by the same action; the two thyroarytenoids relax and shorten them.

The posterior cricoarytenoids separate the vocal cords, and consequently open the glottis, by rotating the arytenoid cartilages outward around a vertical axis passing through the cricoarytenoid articulations, so that their vocal processes and cords attached to them become widely separated. The lateral cricoarytenoids by rotating the arytenoid cartilages inward, close the glottis, and so approximate their vocal processes. The arytenoids approximate the arytenoid cartilages, and thus closes the opening of the glottis, particularly at its back part. The action of the cricothyroids is to raise the anterior portion of cricoid cartilage—while the extrinsic muscles fix the thyroid cartilage—this action depresses the back of the cricoid cartilage, carrying downward the arytenoid cartilages with it, and thus produce tension and elongation of the vocal cords.

The thyroarytenoid shorten the vocal cords by drawing forward the arytenoid cartilages toward the thyroid cartilage. But, owing to the connection of the internal portion with the vocal cord, this part, if acting separately, is supposed to modify its elasticity and tension, and the outer portion being inserted into the outer part of the anterior surface of the arytenoid cartilage, may rotate it inward, and thus narrow the rima glottidis by bringing the two cords together. (Gray.)

The **vessels** of the larynx are derived from the superior laryngeal artery a branch of the superior thyroid artery, and the inferior laryngeal artery, a branch of the inferior thyroid artery. The *veins* are the superior thyroid, which empties into the internal jugular vein, and the inferior thyroid, which empties into the left innominate vein. The **lymphatics** of the larynx are divided into superior and inferior set. The superior accompany the superior laryngeal artery, pierce the thyrohyoid membrane and pass the nodes located at the bifurcation of the common carotid artery; the inferior empty into the deep cervical nodes, a node anterior to the cricothyroid membrane, and the nodes along the inferior thyroid artery. The nerves are the internal and external branches of the superior laryngeal (a branch of the pneumogastric), the inferior or recurrent laryngeal, a branch of pneumogastric, and sympathetic filaments, which accompany the laryngeal nerves. The internal branch of the superior laryngeal supply the mucous membrane, the external branch of the superior laryngeal innervates the cricothyroid muscle. The inferior or recurrent laryngeal nerve innervates all the intrinsic muscles of the larynx except the cricothyroid and a portion of the arytenoid.

THE TRACHEA

The trachea is a membranocartilaginous tube, flattened behind, continuous above with the larynx, and below dividing into the two bronchi.

The trachea consists of sixteen to twenty incomplete cartilaginous rings connected by a fibrous membrane. Their free ends, which are directed posteriorly, are united similarly and by plain muscular tissue. Its upper limit is at the sixth cervical, its lower, opposite the body or upper border of the fifth thoracic vertebra, and it measures about $4\frac{1}{2}$ inches in length; transversely, $\frac{3}{4}$ to 1 inch.

The **relations** are: *In front, in the neck,* the isthmus of the thyroid, the sternohyoid and thyroid muscles and the cervical fascia between them, the arteria thyroidea ima, the inferior thyroid veins, and the communicating branches between the anterior jugulars; *in the thorax,* the manubrium sterni, thymic remains, the left innominate vein, arch of the aorta, innominate and left carotid vessels, and the deep cardiac plexus. *Behind* is the esophagus. *Laterally in the neck,* the common carotids, the lateral lobes of the thyroid, the inferior thyroid arteries, and the recurrent nerves (in the angles between esophagus and trachea); *in the chest,* the pleura of each side and the vagus. The trachea is supplied with blood by the inferior thyroid arteries, branch of the thyroid axis. The veins empty into the thyroid venous plexus. The nerves are derived from the vagus, recurrent laryngeal, and the sympathetic.

THE PLEURÆ AND MEDIASTINUM

The **pleuræ** are two separate serous sacs which invest each lung to its root and are reflected on to the thoracic walls and pericardium. That portion of the serous membrane investing the surface of the lung and extending into the fissures between the lobes is called the visceral layer of the pleura (pleura pulmonalis), while the portion lining the inner surface of the thorax is called the parietal layer of the pleura (pleura parietalis). The latter is subdivided into the cervical, the costal, the diaphragmatic, and the mediastinal portions. The space between the visceral and parietal layers is the pleural cavity (cavum pleuræ), and contains a small amount of clear fluid. Their is no cavity when the pleuræ are in a healthy condition, the two layers being in contact.

The two pleuræ are distinct from each other, and do not meet in the median line except behind the second piece of the sternum. At the root of the lung the visceral and parietal layer of the same side are continuous, and at the lower part of the root, a fold, the ligamentum latum pulmonis, runs down to the diaphragm.

The **blood supply** of the pleura is derived from the intercostal, the internal mammary, the musculophrenic, thymic, pericardiac, and the bronchial. The veins correspond to the arteries. The nerves, are the phrenic and sympathetic. (Luschka.) The **lymphatics** of the visceral layer empty into the superficial pulmonary trunks; the lymphatics of the parietal pleura empty into the intercostal, the diaphragmatic trunks and the posterior mediastinal nodes.

The structure of the pleura is composed of a fibroelastic connective tissue, its free surface covered with a single layer of flat endothelial cells. Subserous tissue fastens the pleuræ to the parietes and the lung respectively.

The **mediastinum** is the space between the two pleural sacs, and extends anteroposteriorly from the sternum to the spine; it is divided into a *superior* mediastinum, above the upper level of the pericardium; the *anterior,* in front of the pericardium; the *middle,* containing the pericardium; and the *posterior* mediastinum, behind the pericardium.

The **superior mediastinum** is bounded by the manubrium sterni in front, the upper four dorsal vertebræ behind, and below by a plane passing from the lower border of the manubrium to the lower part of the fourth dorsal vertebra. It contains the lower part of the sternohyoid and thyroid and longus colli muscles, the transverse aorta, innominate, left carotid, and subclavian arteries, the superior cava (upper half), the two innominate and the left superior intercostal veins, the vagus, cardiac, phrenic, and left recurrent nerves, trachea, esophagus, thoracic duct, thymic remains, and lymphatics.

The **anterior mediastinum** is bounded by the sternum and the pericardium before and behind, by the pleuræ laterally. It runs toward the left, is broader below than above, and contains the origins of the triangularis sterni, the left internal mammary vessels, some areolar tissue containing lymphatics, and the anterior mediastinal glands.

The **middle mediastinum** contains the heart and pericardium, ascending aorta, superior vena cava (lower half), inferior vena cava (upper part), bifurcation of trachea, pulmonary vessels, the phrenic nerves, the deep cardiac plexus, the vena azygos major vein, as it arches over the right bronchus to open into the superior vena cava. Some bronchial lymph nodes are also found in this space.

The **posterior mediastinum** is behind the pericardium and roots of the lungs, and in front of the lower eight dorsal vertebræ, the pleuræ bounding it on each side, the posterior surface of the diaphragm below. It contains the descending part of the arch, the thoracic aorta, the azygos veins, and vagi, and the splanchnic nerves, esophagus, thoracic duct, and some lymphatic glands.

THE LUNGS (PULMONES)

The lungs are the essential organs of respiration; they are situated in the right and left sides of the thorax, covered by the visceral portion of the pleura; filling the cavity, with the exception of the intervening mediastinum, containing the heart, surrounded by the pericardium, the aorta, pulmonary artery, esophagus, thoracic duct, precava and postcava, and the nerves, arteries, and veins, which pass toward and away from the interlying structures.

Each lung presents for examination an apex, a base, diaphragmatic, costal, mediastinal surfaces, and anterior, posterior, and inferior borders. It is suspended within the cavity, by the root and the ligamentum pulmonale. During respiration the lung, covered by the visceral pleura, is pressed against the walls of the thorax interlined by the parietal pleura, and friction is prevented by a small amount of fluid, within the pleural cavity which continually bathes the approximating surfaces.

The apex (apex pulmonis) is rounded, and extends about one inch to two inches above the anterior end of the first rib. It is grooved by the subclavian artery on the left side, but on the right side the impression of the innominate vein is the most prominent groove seen.

The Surfaces.—The base (facies diaphragmatis) is concave, broad, and surrounded by the sharp inferior border. It lies in relation with the superior surface of the diaphragm, which separates the right lung from the convex surface of the right lobe of the liver, and the left lung from the superior surface of the left lobe of the liver, the fundus of the stomach, and the spleen. Laterally and behind the thin sharp margin of the lung projects for some distance into the **costophrenic** sinus of the pleura, found between the lower ribs and the diaphragm. The costal or thoracic surface is convex and smooth. The right lung presents a Y-shaped fissure, which divides it into three lobes; the left lung is crossed by a single fissure, dividing it into two lobes.

The Inner or Mediastinal Surface.—The left surface presents the cardiac depression, which receives the left ventricle, covered by the pericardium; above this is the **hilum** (root of the lung), and passing down around the margins of the latter, two layers of pleura fuse and form the **ligamentum pulmonale,** extending from the lower aspect of the hilum to the inferior border, one to two inches posterior to the interlobar fissure. Immediately above the hilum is seen a large furrow for the transverse portion of the arch of the aorta, and extending upward from this toward the apex is a groove for the left subclavian artery; a slight impression anterior to the latter and approaching the margin of the lung lodges the left innominate vein. Behind the hilum and extending downward and slightly backward is the groove for the descending portion of the thoracic aorta, and in front of this is a slight impression for the esophagus, near the base of the lung, showing that the esophagus is anterior and to the left of the aorta, just before the former pierces the diaphragm. The right surface shows, anterior to the hilum, the cardiac depression, which receives the right ventricle of the heart, covered by the pericardium. Immediately above the hilum is an arched furrow for the vena azygos major vein; as it arches forward above the right branches to empty into the superior vena cava, then running upward and outward below the apex is a wide groove for the superior vena cava and right innominate vein; and nearer the apex and behind the vein is a second depression for the innominate artery. Sometimes a slight impression is seen for the esophagus along the posterior part of the internal surface.

Borders.—The posterior border (margoposterior) is convex and broad, and much longer than the anterior border, and fits into the deep grooves on either side of the spinal column. The inferior border (margoinferior) is sharp and separates the costal and diaphragmatic surfaces. It extends behind into the **costophrenic** sinus of the pleura.

The anterior border is thin and sharp, overlaps the pericardium and extends in front into the **costomediastinal sinus** of the pleura. The anterior border of the right lung is almost vertical; that of the left shows, at the anterior part of the cardiac depression, an angular notch, the incisura cardiaca, into which the left ventricle of the heart, covered by the pericardium is received. Just below this notch a projection of the upper lobe of the lung comes forward overlying the apex of the heart; it is called the **lingula pulmonis.**

Fissures and Lobes.—The left lung is divided into two lobes, an upper and a lower, by an oblique fissure, which extends from the outer to the inner surface of the lung both above and below the hilum. The right lung is divided into three lobes, an upper, middle, and lower, by an oblique fissure, separating the lower and middle lobes, a horizontal fissure separating the upper and middle lobes. The oblique fissure corresponds to the left fissure with the exception that it cuts the inferior border of the lung three inches behind its anterior inferior angle, whereas the left cuts the border an inch behind its extremity. The horizontal fissures cuts the anterior border of the lung at the level of the sternal end of the fourth costal cartilage, on the inner surface, and extends backward to the hilum of the lung.

The right lung is heavier and larger, also shorter and not so broad as the left.

The Root of the Lung (Radix Pulmonis) lies a little above the centre of the mediastinal surface, and approaches nearer to the posterior than its anterior border. It transmits the bronchus, the pulmonary artery, the two pulmonary veins, usually, the bronchial arteries and veins—the former supply the bronchi and lungs with blood—the pulmonary plexus of nerves, lymphatics, the bronchial lymph nodes, and areolar tissue, surrounded by a reflection of the pleura which fuses with the pericardium at this point. The relations of the structures within the root are: From above downward, on the right side, the bronchus, the pulmonary artery, pulmonary veins; the left side, pulmonary artery, bronchus, pulmonary veins. On the right side only the eparterial branch of the bronchus lies above the pulmonary artery.

The true weight of the human lungs as ascertained in the bodies of criminals executed by electricity, in which the mode of death is attended by a nearly bloodless condition of the lungs, is 215 grams ($7\frac{1}{2}$ ounces) for the left lung and 240 grams ($8\frac{1}{2}$ ounces) for the right lung (E. A. Spitzka, *Amer. Jour. of Anat.*, iii, i, p. v). Ordinarily, with the vascular channels more or less filled with blood and serum, the two lungs together weigh about 42 ounces, the right lung being 2 ounces heavier than the left, but much variation is met with according to the amount of blood or serous fluid they may contain. The lungs are heavier in the male than in the female. The specific gravity of the lung tissue varies from 0.345 to 0.746. (Gray.)

The color of the lungs at birth is a pinkish white; in adult life, a dark slate color, mottled in patches; and as age advances this assumes a black color. (Gray.)

The lungs are composed of an external serous coat, subserous areolar tissue, and parenchyma, consisting of the lobules ($\frac{1}{8}$ inch to $1\frac{1}{5}$ inches in size), the terminal bronchioles ending in the alvei, air sacs, or infundibula and the alveoli or saccules; the ramifications of the bronchial and pulmonary arteries, lymphatics and nerves. These are connected by fibroelastic tissue. The blood supply of the lungs is received from the bronchial artery, a branch of the thoracic aorta, and the pulmonary arteries, which are the nutrient vessels of the respiratory epithelium. The bronchial arteries supply the bronchi, bronchioles, and interlobular tissues, as well as the walls of the pulmonary vessels. The right bronchial veins empty into the vena azygos major, the left bronchial veins empty into the left superior intercostal vein or the vena hemiazygos accessoria vein.

THE BRONCHI

The Right.—Enters the hilum of the lung. About one inch from the trachea it gives off a branch above the pulmonary artery, and is, therefore, named the eparterial, which ramifies through the superior lobe. The hyparterial branches are given off below the pulmonary artery and hence the name. Ventral and dorsal branches are given off from the main bronchi, increasing in number and decreasing in size, like the branches of a tree, to end in the bronchioles throughout the lobules of the lung.

The Left.—Has no eparterial branch. The first hyparterial branch is given off 2 inches from the bifurcation of the trachea, and has the same distribution through its branches as the right side.

The right bronchus lies behind the superior cava and the ascending portion of the arch of the aorta, has the vena azygos major vein above and the pulmonary vessels below. The left bronchus passes in front of the descending aorta, has the pulmonary artery above it and the vein below. The phrenic nerves pass in front of the right and left bronchus, and the vagus (pneumogastric) nerves pass behind them.

The bronchi are innervated by nerves derived from the sympathetic and vagi nerves, through the pulmonary plexus.

Their structure resembles the trachea, only that the cartilaginous rings become thinner and are replaced by an increase in the muscular coat, as they approach the terminal bronchioles. The alveoli rest on a basement membrane of elastic tissue, surrounded by a capillary plexus formed by the pulmonary arteries and veins.

THE ORGANS OF DIGESTION

THE MOUTH. ORAL OR BUCCAL CAVITY (CAVUM ORIS)

The **mouth** is the upper part of the alimentary canal. It is bounded by the lips, cheeks, tongue, hard and soft palate, alveolar processes of both jaws, with their contained teeth, and opens behind, through the isthmus faucium, into the pharynx. It is lined by mucous membrane continuous in front with the skin, behind with that of the fauces, its epithelium being stratified.

The **teeth** in the human subject are erupted in two sets, a temporary or deciduous, or milk teeth, and a permanent or succedaneous set. The former are 20 in number, 10 in each jaw; the latter, 32, 16 each above and below. Each tooth is made up of three parts: the root, consisting of one or more fangs, contained in the alveolus; the crown, or body, above the gum; and the neck, between the two. The alveolar periosteum is reflected on to the fang as far as the neck.

The **twenty temporary teeth** are divided into 4 incisors, 2 canines, and 4 molars above and below. The 32 *permanent* teeth are, 4 incisors, 2 canines, 4 bicuspids, and 6 molars in each jaw. The temporary teeth are similar to but smaller than the permanent; of the temporary molars, the hinder one is the largest of all, and its place is afterward taken by the second permanent bicuspid.

Of the **permanent teeth** the **incisors** are the 8 central cutting teeth, 4 each above and below, the former being the larger. They are bevelled at the expense of the posterior surface. The canines (*cuspidati*) are 2 in each jaw, being situated 1 behind each lateral incisor, the upper and larger being called the eye teeth. The bicuspids (*premolars* or *false molars*), 4 in each jaw, lie 2 each behind the canines, the upper being the larger. The **molars** (*true molars* or *multicuspidati*) are the largest teeth, and number 6 in each jaw, 3 each behind the posterior bicuspids above and below. They present 4 tubercles on the upper, 5 on the lower crowns, and the root is subdivided into from 2 to 5 fangs. The first molar is the largest and broadest, the second smaller, and the third (wisdom tooth) the smallest.

A **vertical section of a tooth** shows it to be hollow, the cavity being continuous with the aperture in the fang and filled up with the soft dental pulp, and is hence called the pulp cavity. The pulp is sensitive, highly vascular, and consists of connective tissue, with cells, vessels, and nerves. The hard substance of each tooth consists of three parts: the *ivory*, or *dentine*, the *enamel*, and the *crusta petrosa*, or *cement*.

Eruption.—The teeth are erupted by the absorption of the bone between them and the gum, as well as that covering the labial side of the crown. Thus they are not an upward growth of the tooth, but appear as a result of the absorption of the bone around the crown. The bone covering the lingual surface is more slowly absorbed, as it protects the permanent tooth germ beneath.

The eruption of the temporary teeth commences at the end of the seventh month, and is completed about the end of the second year.

The period of eruption of the temporary teeth are (C. S. Tome):

Lower central incisors	6 to 9 months.
Upper incisors	8 to 10 months.
Lower lateral incisors and first molars	15 to 21 months.
Canines	16 to 20 months.
Second molars	20 to 24 months.

The period of eruption of the permanent teeth are:

First molars	$6\frac{1}{2}$ years.
Two middle incisors	7th year.
Two lateral incisors	8th year.
First bicuspid	9th year.
Second bicuspid	10th year.
Canine	11th to 12th year.
Second molars	12th to 13th year.
Third molars	17th to 21st year.

THE TONGUE (LINGUA)

The tongue is the organ of the special sense of taste, also assisting in insalivation, mastication, and deglutition. It is situated in the floor of the mouth, in the interval between the horizontal rami of the mandible. It is attached to the hyoid bone at the base by the genioglossus and hyoglossus muscles and the hyoglossal membrane; with the epiglottis by three folds, the glossoepiglottic folds, of mucous membrane; with the soft palate by means of the anterior pillars of the fauces; and with the pharynx by the superior constrictor muscles and the mucous membrane.

The muscles controlling the tongue are the extrinsic, which are inserted into the tongue, their terminal fibers contained within the substance, namely: The styloglossus, the hyoglossus, the palatoglossus, the genioglossus, and part of the superior constrictor of the pharynx (pharyngoglossus). The intrinsic muscles of the tongue are: The superior lingualis, the chondroglossus, the transverse lingualis, the vertical lingualis, and the inferior lingualis. These muscles are invested by a submucous fibrous layer, covered by a mucous membrane. It consists of symmetrical halves, separated from each other by a fibrous septum. Each half of muscular fibers is arranged in various directions, containing many glands, and fat, and supplied by vessels and nerves. For purposes of description the tongue is divided into, a body, base, apex, dorsum, margins, and inferior surface.

The body (corpus linguæ) is composed of striated muscle and forms the greatest bulk of the organ.

The base, or root (radix linguæ), is directed backward, is convex and held to the hyoid bone by the hyoglossus and geniohyoglossi muscles and membrane; with the epiglottis by the glossoepiglottic folds, also attached to the soft palate by the anterior pillars of the fauces, and to the pharynx by the palatopharyngei muscles, and the mucous membrane.

The apex (apex linguæ) is thin and narrow, resting against the inner surface of the lower incisor teeth.

The dorsum (dorsum linguæ) is convex from before backward, when at rest. It presents for examination a median longitudinal raphé (sulcus medianus linguæ), which ends in a depression at the posterior part; the foramen cecum (foramen cecum linguæ Morgagni), from which a shallow groove passes outward and forward on each side to the lateral margins; this is called the sulcus terminalis of His. The projections of papillæ are seen through the stratified squamous epithelial cells. They are: (1) The filiform (papillæ filiformes), small and scattered over the apical two-thirds (dorsum and margins) of the tongue; (2) the fungiform papillæ (papillæ fungiformis), scattered (but less numerous than the filiform) over the dorsum, and are more numerous at the sides and apex (they are readily recognized by their large size and deep red color); (3) the circumvallate papillæ (papillæ vallatæ) are large, but only eight to twelve in number. They are arranged in a V-shaped manner just in front of the foramen cecum, and the sulcus terminalis.

The arteries of the tongue are derived from the lingual, the facial, ascending pharyngeal (all branches of the external carotid artery). The veins open into the internal jugular. The lymphatic vessels from the anterior half of the tongue, drain into the submaxillary nodes. Those draining the posterior half end in the deep cervical nodes; along the internal jugular vein. Across the anterior two-thirds of the tongue there is no lymphatic connection between the two sides; in the posterior one-third there is free connection, due to absence of the septum here.

The nerves of the tongue are five in number in each half—the lingual, a branch of the inferior maxillary division of the trigeminal innervates the papillæ on the sides and anterior part of the tongue; it is the nerve of ordinary sensibility for the anterior two-thirds. The chorda tympani is the nerve of taste for the same region, and accompanies the lingual enclosed in the same sheath; the lingual branch of the glosso-pharyngeal innervates the mucous membrane of the base, sides, and circumvallate papillæ, supplying them with sensor and gustatory filaments; the hypoglossal nerve is distributed to the muscular substance of the tongue, supplying them with motor filaments. Sympathetic filaments are furnished from the nervi molles on the lingual and other arteries to the tongue. Some of the nerves end free between the cells of epithelium; others terminate as end organs (Meissner's corpuscles and the end bulbs of Krause), and in taste buds as sensor dendrites. (Gray.)

The **palate** forms the roof of the mouth, and consists of a front part or hard, and a back part or soft palate. The periosteum of the hard palate (see *Bones*) is covered by and intimately connected with the mucous membrane of the mouth. In the middle line is a raphé ending in front at a small papilla, which marks the anterior palatine fossa which receives the terminal part of the anterior palatine and nasopalatine nerves. The mucous membrane is pale and corrugated, covered with squamous epithelium, and furnished with a number of palatal glands which lie between it and the bone.

The **soft palate** partially separates the mouth and pharynx. It consists of muscular, connective, and adenoid tissue, with vessels, nerves, and mucous glands, all enclosed in a fold of mucous membrane. Above it is joined to the back of the hard palate; laterally it blends with the pharynx; below it is free; in front it is concave, with a median ridge; and behind it is convex. Its mucous membrane is continuous with that of the roof of the mouth and of the posterior nares.

From its lower border a conical process depends, the *uvula*, from whose base descend the *pillars* of the soft palate, the anterior, formed by the *palatoglossi muscles*, to the sides of the base of the tongue; the posterior, formed by the *palatopharyngei*, to the sides of the pharynx. These pillars are covered by mucous membrane and separated below by the tonsil, the space being called the isthmus of the fauces. The muscles of the soft palate are five on each side, and lie in the following relative position from before backward: The palatoglossus, tensor palati, anterior fasciculus of palatopharyngeus, levator palati, azygos uvulæ, and lastly the posterior fasciculus of the palatopharyngeus.

The **tonsils** (tonsilla palatina) are two in number, situated on each side of the fauces, and lie between the anterior and posterior palatine pillars, and are about $\frac{1}{2}$ inch long and $\frac{1}{3}$ inch wide and thick, but vary much in size. Externally they are separated by the superior constrictors from the internal carotid artery, which is about 1 inch away from it, also lies to the outer side, and ascending pharyngeal arteries; internally they project into the fauces, and present 12 or more orifices which lead into the crypts in their substance. Around the crypt walls are numerous lymphoid follicles consisting of adenoid tissue. The arteries supplying the tonsil are: The dorsalis linguæ, a branch of the lingual; the ascending palatine and tonsillar from the facial; the ascending pharyngeal from the external carotid; the descending palatine, a branch of the internal maxillary, and a small meningeal branch. The veins empty into the internal jugular or facial vein, after passing from the tonsillar plexus (on the external surface of the tonsil), to the pharyngeal plexus, then the pterygoid plexus. The lymphatic vessels drain into the submaxillary and retropharyngeal nodes and thence to the deep carotid nodes. The nerves of the tonsil are the filaments derived from the tonsillar plexus, formed by branches from the glossopharyngeal joining with branches of the pharyngeal plexus.

THE SALIVARY GLANDS

There are three pairs, *parotid, submaxillary,* and *sublingual.*

The **parotid gland**, the largest, weighs $\frac{1}{2}$ to 1 ounce, and lies on the face below and in front of the ear. Its outer surface, lobulated, is covered by the skin and fascia, and partly by the platysma and several lymphatic glands; in front it runs over the masseter, is grooved for the ramus of the lower jaw, and extends beneath it, between the two pterygoids; above it is bounded by the zygoma; below, by the angle of the jaw and a line joining it with the mastoid process; behind, by the external meatus, mastoid process, and sternomastoid. The internal surface sends two processes into the neck—one behind the styloid process and beneath the mastoid process and sternomastoid; another in front of the styloid process, into the back of the glenoid cavity behind the jaw. Embedded in the gland are found the external carotid, posterior auricular, temporal, transverse facial, and internal maxillary arteries, the temporomaxillary vein and a branch from it to the internal jugular, the facial nerve with its branches, and the auriculotemporal and great auricular nerves. The internal carotid artery and internal jugular vein lie under its deep surface.

The *duct* (Stenson's) is about $2\frac{1}{2}$ inches long and $\frac{1}{8}$ inch in diameter, and opens opposite the second molar tooth, thence runs backward beneath the mucous membrane, through the buccinator, and across the masseter to the front of the gland. It commences by numerous branches, and on the masseter receives the duct of a detached part of the gland, the *socia parotidis*, which sometimes is found beneath the zygomatic arch. Its epithelium is columnar.

The **submaxillary gland** is of an irregular form, weighs about 2 drams, and lies below the jaw and above the digastric muscle. It is covered by the skin, platysma, and fasciæ, and grooves the inner surface of the lower jaw. It lies on the mylohyoid (partially embracing this muscle), hyoglossus, and styloglossus, and has in front of it the anterior belly of the digastric. Behind, the stylomaxillary ligament separates it from the parotid, and the mylohyoid (its superficial part) from the sublingual gland in front. The facial artery grooves its upper and back part.

The *submaxillary duct* (Wharton's) is 2 inches long, and opens at the top of a papilla close to the frenum linguæ. Thence it runs back between the sublingual gland and the geniohyoglossus, then between the mylohyoid and the hyoglossus and geniohyoglossus.

The **sublingual gland**, the smallest of the salivary glands, lies at the side of the frenum linguæ and against the inner surface of the lower jaw, beneath the mucous membrane. It is almond-shaped, weighs 1 dram, and its ducts (of *Rivini*), ten to twenty in number, open separately, one or two joining to form the duct of Bartholin, which joins Wharton's duct. It is in relation below with the mylohyoid; in front, with its fellow and the lower jaw; behind, with the submaxillary gland; internally the gustatory nerve and Wharton's duct separate it from the geniohyoglossus.

The **arteries** supplying the **parotid gland,** are derived from the external carotid, and the branches given off within its substance; the blood supply of the **submaxillary gland** is from the facial and lingual; the **sublingual gland** from the sublingual artery, a branch of the lingual, and the submental, a branch of the facial artery. The **veins** of the parotid empty into the external jugular; those from the submaxillary gland open into the facial and lingual; the veins from the sublingual gland open into facial and lingual through the submental and sublingual veins. The **lymphatics** of the parotid drain into the external jugular and the upper deep cervical nodes; the submaxillary into the submaxillary nodes; the sublingual lymphatics drain into the submental nodes, and the efferents pass to the submaxillary nodes. The **nerves** of the parotid gland are the auriculotemporal, nervus intermedius, great auricular, and from the sympathetic plexus found on the external carotid artery; the innervation of the submaxillary is from the chorda tympani and lingual (a branch of the inferior maxillary division of the trigeminus), through the submaxillary ganglion and its sympathetic filaments; the sublingual is supplied by branches from the lingual nerve, and sympathetic filaments, derived from the chorda tympani through the sublingual plexus. The sympathetic filaments are all efferent.

THE PHARYNX

The pharynx is a musculomembranous tube, conical in shape, between the oral cavity and the esophagus; communicating with the posterior nares, the oral cavity, the larynx, the two Eustachian tubes, the esophagus. It is attached above to the periosteum of the petrous portion of the temporal bone and the basilar process of the occipital bone. The raphé of the constrictor muscles is attached to the pharyngeal tubercle of the basilar process of the occipital bone. It is bounded above by the body of the sphenoid and basilar process of the occipital; below, it is continuous with the esophagus; anteriorly, it is incomplete, and is attached to the Eustachian tube, the internal pterygoid plate, the pterygomandibular ligament, the posterior portion of the mylohyoid ridge, the mucous membrane of the mouth, the base of the tongue, the hyoid bone, the thyroid and cricoid cartilages; posteriorly, the prevertebral fascia, and the areolar tissue connects it to the cervical portion of the vertebral column, anterior to the longus colli and rectus capitis anticus muscles, areolar tissue is contained in the retropharyngeal space; laterally, it is connected to the styloid process and its muscles. The internal jugular veins; the internal and common carotid, the ascending pharyngeal arteries, and the glossopharyngeal, the vagus, hypoglossal, and sympathetic nerves, lie externally above, with a small portion of the internal pterygoid muscles. The constrictor muscles surround it and aid in deglutition. It is $4\frac{1}{2}$ inches long, and for purposes of studying, divided into a nasal, oral, and laryngeal portion.

The nasal part, or nasopharynx, lies posterior to the nares and above the soft palate. In front are the posterior nares (choanæ); behind, the pharyngeal tonsil, consisting of lymphoid tissue, seen above the orifices of the Eustachian tubes in the median line. Below the vault of the pharynx is an irregular flask-shape depression of the mucous membrane, called the pharyngeal bursa, a possible vestige of the pharyngeal tonsil. The floor of the nasopharynx is continuous with the nasal fossæ, anteriorly, and behind is the sloping portion of the soft palate. On its lateral wall is the orifice of the Eustachian tube, level with the inferior turbinated bone and one-third to one-half inch posterior to its dorsal extremity. Behind the Eustachian tube is the Eustachian cushion, caused by the inner extremity of the cartilage of the tube, which elevates the mucous membrane. Extending from the lower portion of the cushion is the salpingopharyngeal fold, and from the upper part passes the salpingopalatine fold. The deep recess behind the cushion is called the fossa of Rosenmüller (recessus pharyngeus).

The oral part, or oralis pharyngis, extends from the soft palate to the level of hyoid bone. It opens into the oral cavity, through the fauces, bounded on either side by the anterior and posterior pillars, between which are the tonsils.

The laryngeal part is continuous with the oral portion above, and below at the level of the cricoid cartilage is continuous with the esophagus. Anteriorly, it presents the aperture of the larynx, bounded in front by the epiglottis, and laterally by the arytenoepiglottic folds. On either side of the aperture is the sinus pyriformis, bounded internally by the arytenoepiglottic folds and laterally by the thyroid cartilage and thyrohyoid membrane.

The pharynx is lined with mucous membrane continuous with that lining the Eustachian tube, the nasal fossæ, the mouth, and the larynx. In the nasopharynx it is covered by stratified ciliated epithelium; in the buccal and laryngeal portions it is of the stratified squamous variety.

The arteries are derived from the ascending pharyngeal, ascending and descending palatine, the tonsillar. The veins empty into the pharyngeal and facial plexuses. The lymphatics drain into the retropharyngeal nodes in the retropharyngeal space and the upper deep cervical nodes.

THE ESOPHAGUS

The **esophagus** is the tube connecting the pharynx with the stomach, and extends from the level of the sixth cervical vertebra through the diaphragm, entering the stomach opposite the tenth or eleventh dorsal vertebra, a distance of 9 or 10 inches, and from the incisor teeth to the beginning of the esophagus is about 6 inches; thus making the distance from the incisor teeth to the cardiac opening of the stomach 15 to 16 inches. At first in the median line it runs to the left as far as the root of the neck, becomes again mesial, and lastly turns toward the left to pass through the esophageal orifice in the diaphragm. It also corresponds to the cervical and dorsal curves of the spine. It is the narrowest part of the alimentary canal, and presents two constrictions, one at its commencement, the other at the diaphragm.

In the neck it is **in relation,** *in front,* with the trachea; *behind* with the longus colli and spinal column; *laterally,* with the common carotid arteries and part of the thyroid gland. Between it and the trachea ascend the recurrent laryngeal nerves.

IN THE CHEST it is **in relation**, *in front*, with the trachea, left bronchus, arch of the aorta and left carotid artery, and pericardium; *behind*, with the spine, longus colli, thoracic duct, and a portion of the descending thoracic aorta, where the esophagus crosses from right to left before piercing the diaphragm; *laterally*, with the pleuræ, and on the right side the large azygos vein, and on the left the aorta except near the diaphragm, where the aorta lies to the right side. The right vagus is behind and the left in front of the esophagus, but at first each is on the corresponding side.

The arteries are derived from the inferior thyroid, a branch of the thyroid axis of the subclavian; from the esophageal and bronchial arteries, branches of the descending thoracic aorta; the gastric from the celiac axis, and the left inferior phrenic of the abdominal aorta. The veins form a plexus on the outer side of the esophagus, emptying into the thyroid, vena azygos major, and the gastric vein. Thus the portal vein can communicate with the systemic veins. The lymphatics drain into the inferior left cervical nodes, and the nodes of the posterior mediastium. The nerves are derived from the vagus and sympathetic system. They form the anterior and posterior esophageal plexuses.

THE PERITONEUM

The peritoneum is a closed serous sac, which invests more or less completely the contents of the abdominal and pelvic cavities, sending in processes or diverticula between the adjacent viscera. These processes are attached to the surfaces of the viscera, forming their investment, and serving also to separate and allow a free movement between them without friction. Moreover, they confine the viscera to their proper relative positions.

The peritoneum is very thin, the attached surface being rough, the free, smooth and moist, and covered with a layer of mesothelium. That part which is attached to the inner surface of the abdominal walls is called the parietal layer, while that investing the viscera constitutes the visceral layer.

(NOTE.—The adult peritoneum will never be fully understood until the student acquires a thorough knowledge of the development of the intestinal canal in the embryo, and the books on embryology should be carefully studied on this subject.)

The General Arrangement of the Peritoneum.—Starting from the anterior abdominal wall, in the median line, the peritoneum passes around on the right side to invest completely the lower part of the cecum and the vermiform appendix, but only partially investing the rest of the cecum, covering its front and sides, the back part being very often uncovered. It partially invests the entire ascending colon in a similar manner. Quite often, however, the back part of the cecum is also covered by the peritoneum, which thus forms a mesocecum. It now covers the lower part of the front of the right kidney and the front of the third portion of the duodenum, excepting a transverse zone, passes thence to the spine, and forming the right side of the mesentery invests the jejunum and ileum, and returns, as the left layer of the mesentery to the spine, thus completing the structure. The peritoneum now crosses the lower part of the left kidney, invests the descending colon in a manner similar to that on the right side, forms a long sigmoid mesocolon, and returns to the front of the abdomen.

Starting in the median line behind at the sacral angle we may trace the peritoneum downward to invest completely the rectum in its upper part and partially invest it in its second portion, covering it in front, and laterally, and lower down, only in front, and at a point about 6 to 8 cm. above the anus leaves the gut altogether. It is then reflected on to the base and upper part of the bladder in the male, forming the rectovesical pouch. This pouch presents on each side a fold, the plica semilunaris. From the apex of the bladder it ascends, investing the urachus and obliterated hypogastric artery on each side. In the female it passes from the rectum to the upper part of the vagina, forming the rectovaginal pouch (or cul-de-sac of Douglas), which presents plicæ semilunares similar to those found in the rectovesical pouch in the male. It then covers both surfaces of the uterus, and forms the broad ligaments, investing the Fallopian tubes to the fimbriated ends, where it becomes continuous with their mucous membrane.

Above, the peritoneum runs on the under surface of the diaphragm as far back as the esophageal opening, and near that opening meets the process of the *lesser sac*, which lies on the posterior surface of the liver. It passes to the liver, forming the superior layers of the lateral and coronary ligaments. At the anterior border of the liver it is reflected on to its under surface, and at the transverse fissure it meets the posterior layer of the lesser or gastrohepatic omentum from the lesser sac, and passes with it to the lesser curvature of the stomach as the anterior layer, thus completing the lesser omentum. Thence it passes over the anterior surface of the stomach to the greater curvature, then down to the greater omentum.

To the right from the quadrate lobe it invests the gall-bladder to a variable degree, the under surface of the right lobe of the liver passing back to the posterior surface of the liver as far as the coronary and right lateral ligaments, of which it forms the lower layer (the layers are separated by a considerable space). It then turns down over the diaphragm to the front of the second portion of the duodenum, and the upper part of the right kidney, forming here the fold known as the hepatorenal ligament. Lastly, it invests the hepatic flexure of the colon, and proceeds to the right colon in the manner previously described.

To the left it covers the entire under surface of the left lobe of the liver back to the left lateral ligament, of which it forms the inferior layer; there it turns down on the diaphragm, to the left of the esophageal opening.

Tracing to the left the anterior layer of the lesser omentum, the peritoneum covers the front and left side of the esophagus and left end of the stomach, passing thence to invest the spleen, and forming the anterior layer of the gastrosplenic omentum. Passing from the diaphragm to the stomach to the left of the gullet, there is formed the gastrophrenic fold or ligament, and between the diaphragm and splenic flexure the costocolic ligament.

The **lesser sac of the peritoneum** is a process which lines the space bounded by the posterior and inferior surfaces of the Spigelian lobe of the liver and the posterior wall of the stomach and the upper surface of the transverse colon. It communicates with the greater sac by means of the foramen of Winslow, which is bounded in front by the lesser omentum, with the portal vein and hepatic artery and duct between its layers, behind by the vena cava inferior and right crus of the diaphragm, above by the lobus caudatus, below by the duodenum and hepatic artery. From this point the lesser sac lines the posterior abdominal wall, and adheres to the back of the greater sac except where the stomach comes between. Above it passes behind the liver, between the Spigelian lobule and the back part of the diaphragm, to meet the process from the greater sac already described. Here it is attached to the transverse fissure and the fissure of the ductus venosus, covering the esophagus behind and on the right. At the transverse fissure it passes to the lesser curvature of the stomach, forming the posterior layer of the lesser or gastrohepatic omentum, the anterior layer coming from the greater sac.

It then invests the back of the stomach, and descends from the great curvature in front of the transverse colon and small intestine to a variously greater or less extent. Turning upon itself, it ascends, thus forming the internal layers of the great omentum, as far as the transverse colon, whose upper surface it invests, and passes thence to the spine, thus forming the upper layer of the transverse mesocolon. It now passes upward over the front of the pancreas, celiac axis and its branches, upper part of left kidney, the left suprarenal capsule, and that part of the diaphragm between the aortic and caval openings, and is continuous with that part of the lesser sac lining the space back of the liver, already described. Traced to the left over the pancreas, the peritoneum is reflected to the hilum of the spleen, and thence to the stomach, forming the posterior layer of the gastrosplenic omentum. Traced to the right, it is reflected from the extreme end of the pancreas on to the back of the first portion of the duodenum, and becomes continuous with that covering the posterior surface of the stomach.

The anterior layer of the lesser omentum invests the front of the stomach to the greater curvature, from which it descends in front of and with the posterior layer, and thus down in front of the transverse colon and small intestine to a variable degree. These two layers are closely adherent to each other in adults and turn backward upon themselves to ascend to the transverse colon, thus completing the **great omentum.** Those layers, therefore, of the great omentum, which are contributed by the lesser sac, are continued within those from the greater sac. At the transverse colon the layers of the greater omentum separate and enclose the gut, meeting behind and completing the transverse mesocolon, which extends to the lower border of the pancreas. Here the inferior layer (from the greater sac) runs down along the posterior abdominal wall and blends with the mesentery as described, and the superior layer (from the lesser sac) proceeds as already mentioned.

The peritoneum forms certain pouches or cul-de-sacs, which are essential to the surgeon, owing to their being sites for the possible occurrence of retroperitoneal or intra-abdominal hernia. They are the **lesser sac**; through the foramen of Winslow, the duodenal **fossæ**; the **pericecal fossæ**; and the **intersigmoid fossæ.**

The **duodenal folds,** or **fossæ**: (1) The **inferior duodenal fossa,** or **fossa of Treitz,** is present in from 70 to 75 per cent. of cases. It is found opposite the third lumbar vertebra on the left side of the ascending or fourth portion of the duodenum; and is bounded by a thin free fold of peritoneum, called the **inferior duodenal fold.** (2) The **superior duodenal fossa** is present in about 40 to 50 per cent. of the cases. It is found to the left of the duodenum, bounded by the thin free edge of the **superior duodenal fold**; to the right it is blended with the peritoneum covering the ascending duodenum, and on the left with the peritoneum covering the perirenal tissues; behind is the second lumbar vertebra. (3) The **duodenojejunal fossa, or mesocolic fossa,** is seen by pulling the jejenum downward and to the right, after raising upward the transverse colon. It is circular in shape, bounded above by the free margins of peritoneum, called **right and left duodenomesocolic ligaments.** Above is the body of the pancreas, to the right the aorta, and to the left lies the left kidney, behind the left renal vein. It is present in about 15 to 20 per cent. of the cases. (4) The **paraduodenal fossa, or fossa of Laudzert,** is very seldom seen, and usually in the infant when present. It is found to the left of the ascending duodenum, the fold of peritoneum bounding it above is formed by the inferior mesenteric vein. Its lower boundary is a free edge, called the **mesentericomesocolic fold.** (5) The **retroduodenal fossa** is a peritoneal cul-de-sac, first described by Jonesco in 1893, and is found between the ascending and transverse portions of the duodenum.

Pericecal folds and fossæ are found in the region of the cecum. (1) The **superior iliocolic fossa** is found between the **iliocolic fold** in front, the mesentery of the small intestine, the ileum, and a small portion of the cecum behind. It is a very narrow space. (2) The **inferior ileocecal fossa** (or ilio-appendicular) is found behind the angle of junction of the ileum and cecum. It is bounded by the **ileocecal fold**, or "bloodless fold" of Treves, which is attached by its upper extremity to the ileum, opposite its mesenteric attachment, while the lower extremity, passing over the ileocecal junction, is attached to the mesoappendix, and sometimes the appendix; it is thus called the **ileoappendicular fold.** The ileocecal fossa is bounded above by the posterior surface of the ileum and its mesentery; in front and below by ileocecal fold, and behind by the upper part of the mesoappendix. (3) The **retrocecal fossa** is found behind the cecum; seen only on raising the cecum. It is the space found between the **superior cecal fold**, on the right side, one edge is attached to parities and extends from the lower pole of the kidney to the iliac fossa and by the other to the posteroexternal aspect of the colon and cecum, on the left side by the **inferior cecal fold**, which is essentially the insertion of the mesentery into the iliac fossa.

The **intersigmoid fossa** is constant in the fetus and during infancy, seldom seen in the adult. After raising the sigmoid flexure of the colon it will be seen on the left surface of the sigmoid mesocolon; a small recess lying on the external iliac vessels, in the interspace between the psoas and iliacus muscles. This is the orifice leading to the fossa intersigmoidea, which lies behind the sigmoid mesocolon, and in front of the parietal peritoneum.

THE STOMACH (GASTER)

The stomach lies in the epigastrium, left hypochondrium, and sometimes the mesogastrium. It is the most dilated portion of the alimentary canal. Its shape is pyriform; the left or larger portion is called the **cardia**, and below this is the **fundus**; the right end is termed the **pylorus.** The right opening of the stomach is called the **pyloric orifice**, and the left the

esophageal orifice; the former opens into the duodenum, and the latter into the esophagus. It is 10 to 12 inches in length, 4 to 5 inches in the vertical direction, and weighs 4 to 5 ounces. Its capacity is from 3 to 6 pints.

The **cardiac orifice** is the highest part of the stomach, and lies behind the seventh costal cartilage 1 inch to the left of the sternum. The **pyloric orifice** lies about 2 inches to the right of the mid-line, on a level with the upper border of the first lumbar vertebra; it is guarded by a valve, the pylorus. Between the two orifices the stomach is sickle-shaped and presents an upper concave border, the **lesser curvature**, and a lower convex border, the **greater curvature.** The former gives attachment to the **gastrohepatic** or **lesser omentum,** the latter affords attachment to the great omentum. The upper end of the stomach is enlarged 2 to 3 inches to the left of the cardiac orifice, to form the fundus or great cul-de-sac, which is connected to the spleen by the **gastrosplenic omentum.** The pyloric orifice is anterior and inferior to the fundus, and is in relation with the quadrate lobe of the liver and belly wall. The stomach presents two **surfaces,** an **anterosuperior** and **posteroinferior.**

The **relations of the anterosuperior surface** are: Diaphragm, under surface of left lobe of liver (pylorus), quadrate lobe of liver, abdominal wall, thoracic wall, formed by the corresponding seventh, eighth, and ninth ribs. **Posteroinferior** surfaces are: Diaphragm, the gastric surface of the spleen, the left suprarenal gland, the upper part of the front of the left kidney, the anterior surface of pancreas, the splenic flexure of colon, and the upper layer of the transverse mesocolon. These structures form a shallow cavity on which the stomach rest, and is termed the **stomach bed.** The stomach is entirely covered by peritoneum, except over a small area close to the cardiac orifice, on the posteroinferior surface; this area is limited by the lines of attachment of the gastrophrenic ligament.

The stomach has a *serous* (peritoneal) coat, a *muscular* coat comprising a longitudinal, circular, and oblique layer, an *areolar* coat of loose tissue (submucous coat), and a *mucous* coat. The latter is thickest near the pylorus, thinnest at the fundus, and presents, in the empty condition of the organ, numerous ridges, or *rugæ*, which run longitudinally along the great curvature. Studded over its surface are many small polygonally-shaped depressions, which are the enlarged mouths of the gastric tubular glands. These are of two kinds, called pyloric and peptic glands; some are simply tubular, while others have several branches opening into a common duct. The *pyloric glands* are most numerous at the smaller end, but the *peptic glands* are found all over the stomach, the ducts of the latter being shorter. In the latter, between the basement membrane and the lining epithelium, are numerous peptic or parietal cells, the others being known as the central or chief cells. Between the glands the mucous membrane contains lymphoid tissue, collected here and there into little masses resembling the solitary intestinal glands, and called the lenticular glands. Beneath the membrane is a muscularis mucosæ. The **arteries** are: To the lesser curvature and part of the anterior and posterior surfaces, the gastric artery from the celiac axis, the pyloric from the hepatic; to the greater curvature and anterior and posterior surfaces, the gastroepiploica dextra, from the gastroduodenal, a branch of the hepatic; the gastroepiploica sinistra from the splenic. The gastric gives off a branch to the esophagus at the cardiac orifice, and passing along the lesser curvature anastomoses with the pyloric artery. The gastroepiploica arteries anastomose along the greater curvature, supplying the great omentum. The vasa brevia, 4 or 5 in number, are derived from the splenic and pass to the fundus of the stomach, anastomosing thereon, with the gastric and gastroepiploica sinistra arteries. The **veins** accompany the arteries. The gastric and pyloric open into the portal vein; the gastroepiploica sinistra into the splenic; the gastroepiploica dextra, the superior mesenteric vein. The **nerves** are derived from the vagus, the left supplying the anterosuperior surface, the right the posteroinferior surface. The sympathetic filaments from the celiac plexus (solar plexus) join with the vagus to form the plexus of Auerbach and Meissner; the former is found in the muscular coats, the latter in the submucous coat. Auerbach's plexus is formed by fibers from Meissner's plexus (Gray).

The **lymphatics** of the stomach are divided into: (1) The gastric nodes, which drain the lower end of the esophagus and the cardiac end of the stomach, emptying into the celiac nodes; (2) a set that drain the fundus, draining the area supplied by the vasa brevia and left gastroepiploica sinistra arteries, and empty into the splenic nodes, situated around the hilum of the spleen; (3) a set which drains the greater curvature and ends in the right gastroepiploic nodes, the efferents of which pass to the subpyloric nodes; (4) those draining the pylorus empty into the hepatic and subpyloric nodes.

SMALL INTESTINE

The Duodenum

The **duodenum** is about 10 inches long, and runs in a curved direction from the pylorus to the jejunum, which it joins on the left side of the second lumbar vertebra. The concavity of the curve looks toward the left and embraces the head of the pancreas. It is divided, for description, into four parts or portions.

The **first portion of the duodenum** is almost completely surrounded by peritoneum, derived from the two layers of the lesser omentum, except a small space, posteriorly, near the neck of the gall-bladder and the vena cava. **The second portion** is covered by peritoneum anteriorly, except where it is in relation with the transverse colon. **The third portion** is covered by peritoneum anteriorly, except where the superior mesenteric vessels cross, about its middle aspect. **The fourth portion** is fixed by peritoneum to the abdominal wall, which covers it anteriorly.

The **first portion** extends from the pylorus to the neck of the gall-bladder. Its length varies in different subjects, and its direction changes with the degree of distention of the stomach.

The **second portion** extends from the neck of the gall-bladder down along the right side of the vertebral column, usually to the body of the fourth lumbar vertebra. It is 3 or 4 inches long.

The **third portion** begins where the second ends and passes from right to left over the great vessels and crura of the diaphragm in front of the third or fourth lumbar vertebra. It is 2 or 3 inches long.

The **fourth portion** ascends along the left side of the vertebræ and aorta upon the left crus of the diaphragm and ends at the left side of the second lumbar vertebra. It is about 2 inches long. This portion ends in the duodenojejunal flexure, being held in position by the peritoneum, and the duodenojejunal flexure is further bound down by the suspensory muscle of the duodenum or the suspensory ligament of Treitz. This consists of a few non-striated muscle fibers fused with connective tissue. It arises from around the celiac axis and left crus, to be inserted into the duodenojejunal flexure, and a portion of the ascending portion of the duodenum.

The Relations of the Duodenum.—The first or superior portion has above and in front the gall-bladder, the quadrate lobe of the liver; behind is the gastroduodenal artery, the common bile duct, the portal vein; below is the head of the pancreas. It helps to form the lower boundary of the foramen of Winslow.

The second or descending portion is crossed by the transverse colon, which is attached to it by connective tissue; above and in front is the right lobe of the liver; behind is the inner part of right kidney, the renal vessels, and the inferior vena cava; to the inner side is the common bile duct and the head of the pancreas; outerside is the hepatic flexure of colon. The transverse colon divides the duodenum in this portion, into a supracolic and infracolic region.

The third portion is crossed in front by the superior mesenteric vessels and the mesentery; behind it rests on the inferior vena cava, the aorta, and crura of the diaphragm. Above is the head of the pancreas.

The fourth or ascending portion has behind the aorta, the left renal vessels, the left psoas muscle; to the right is superior mesenteric vessels and the uncinate process of the head of the pancreas; to the left and posterior are the duodenojejunal folds and fossæ.

The arteries are the pyloric, the superior pancreaticoduodenal from the hepatic, and gastroduodenal respectively; the inferior pancreaticoduodenal, a branch of the superior mesenteric. **The veins** correspond to the arteries. The superior pancreaticoduodenal opens into the gastroduodenal, the inferior pancreaticoduodenal into the superior mesenteric vein. **The nerves** are derived from the solar plexus. The lymphatics empty into the celiac nodes of the preaortic group.

The Jejunum and Ileum

The *jejunum* includes the first two-fifths of the remaining part of the small intestine, running from the left side of the first or second lumbar vertebra to the beginning of the ileum, and occupying the umbilical and left lumbar and iliac regions. Its coats are thicker and more vascular, and is of a deeper color and larger caliber than the ileum.

The arteries supplying the jejunum are derived from the superior mesenteric and are called the arteria intestine tenuis. They are arranged in loops between the mesentery; single loops near the beginning, then double and even tertiary loops are seen as the ilium is approached. **The veins** correspond to the arteries and empty into the superior mesenteric vein, which unites with the splenic to form the portal. There are no valves in the mesenteric veins.

The nerves are derived from the celiac axis (sympathetic) and some from the vagus. The plexus of Auerbach is found in the muscular coat, and Meissner's plexus is situated in the submucous coat, and is made up from filaments of the celiac plexus and vagus. The lymphatics pass to the mesenteric nodes, between the layers of the mesentery.

The remainder of the small intestine is the *ileum,* which ends by opening into the inner side of the commencement of the large gut in the right iliac fossa. Its coils occupy the hypogastric, umbilical, and right lumbar and iliac regions.

THE LARGE INTESTINE

The large intestine is that part of the alimentary canal which extends from the end of the ileum to the anus; it is about $5\frac{1}{2}$ feet long. It commences by a dilated part, the *cecum,* in the right iliac fossa, ascends to the under surface of the liver, then runs transversely across the abdomen to the vicinity of the spleen, descends to the left iliac fossa, and forms the sigmoid flexure, and finally passes along back of the pelvis to end at the anus.

The **cecum** is the large cul-de-sac which is the beginning of the large intestine, and is about 3 inches broad and $2\frac{1}{4}$ inches long. It is variously situated, being found on the psoas, external to it, on the iliacus, internal to it, on the pelvic brim, or entirely within the pelvis. In any of these positions it is entirely surrounded by peritoneum.

The **vermiform appendix** comes off from the inner and back part of the cecum, near its lower end, and extends upward and inward behind it. This is a piece of gut of the diameter of a goose-quill, varying from 3 to 6 inches in length, curved upon itself, and ending in a blind extremity. It tapers gradually to its end, which is blunt, is completely invested by the peritoneum, which forms for it a mesentery (mesoappendix), and at its connection with the cecum is guarded by an imperfect valve (**valve of Gerlach**). This is not always constant.

The **ileocecal valve** guards the opening of the small intestine into the large gut. This junction is oblique and situated about $2\frac{1}{2}$ inches above the lower extremity of the cecum. It is a double fold lying transversely to the long axis of the colon. Each fold of the valve is made up of the mucous and submucous coats, reinforced by some circular fibers from the muscular coat, of each portion of the gut, and is covered on the side toward the ileum with villi. At each end of the opening these folds run together and are prolonged some distance around the gut, forming the *retinacula.*

The **ascending colon** runs from the cecum, above the ileocecal valve, upward to the under surface of the liver on the right side of the gall-bladder, and then turns forward and to the left to form the *hepatic flexure.* The peritoneum rarely forms for it a mesocolon; generally it covers only the front part and the sides. It occupies the right lumbar and hypochondriac regions.

The **transverse colon** arches across the abdomen, the convexity looking toward the belly wall, and makes a sudden turn backward and downward beneath the spleen, forming the *splenic flexure,* and is completely invested by the peritoneum, which holds it to the anterior aspect of the pancreas and second portion of the duodenum; by two layers of peritoneum called the transverse **mesocolon**, the upper surface of which fuses with the posterior layer of the great omentum. It occupies the right hypochondriac, upper part of umbilical, and left hypochondriac regions. At the splenic flexure is attached the *phrenocolic ligament,* a fold of peritoneum extending to the diaphragm opposite the tenth or eleventh rib.

The **descending colon** descends from the splenic flexure, to end at the left iliac fossa in the sigmoid flexure. It is covered in front and laterally by the peritoneum. It occupies the left hypochondriac and lumbar regions.

The Relations of the Cecum.—It lies in the right iliac fossa, resting on the ileopsoas muscle, immediately behind the abdominal wall. The appendix, the first lumbar nerve, the genitocrural, and external cutaneous branches of the lumbar plexus are in relation with it behind. Internal at the brim of the pelvis are the external iliac vessels and the ureter, as it crosses the bifurcation of the common iliac.

The arteries of the cecum are: The anterior and posterior cecal arteries, branches of the iliocolic. They are given off at the ileocecal junction. **The veins** are the same as the arteries and open into the superior mesenteric vein through the ileocolic. They are radicles of the portal system. **The nerves** are derived from the sympathetic system, through the superior mesenteric plexus. **The lymphatics** drain into the superior mesenteric nodes through the channels of the ileocecal nodes.

The Relations of the Ascending Colon.—In front, the coils of the ileum and abdominal wall; behind, the quadratus lumborum muscle, the lower thoracic intercostal nerves, the anterior and lower surface of the right kidney; above, the hepatic flexure of the colon rests against the inferior surface of the right lobe of the liver in the **impressiocolica** and the gall-bladder. Internally, the second portion of the duodenum touches the hepatic flexure.

The Relations of the Transverse Colon.—It describes an arch with its concavity directed backward and upward to the vertebral column. Above, it is in touch with the liver and gall-bladder, the greater curvature of the stomach, the lower end of the spleen; below with the small intestines; by its anterior surface with the layers of the great omentum and the abdominal wall; posteriorly it rests, the right side, on the second portion of the duodenum and head of the pancreas, and on the left side is in relation with coils of the jejunum and ileum.

The splenic flexure is in relation with the posteroinferior surface of the stomach, the tail of the pancreas, and the diaphragm opposite the tenth and eleventh ribs. The phrenocolic ligament attaches it to the diaphragm.

The Relations of the Descending Colon.—Passes to the iliac fossa, to the left of the left kidney and psoas muscle; in front are the coils of the jejunum and ileum; behind, is the quadratus lumborum muscle and the twelfth thoracic nerve.

The **sigmoid flexure** ends in the rectum. From the end of the descending colon it forms an S-shaped curve, ending opposite the left sacroiliac joint. In front of it are the belly wall and some coils of small intestine. The peritoneum forms a loose mesocolon for it. It is the narrowest part of the colon.

The Relations of the Sigmoid Flexure of the Colon.—Anteriorly, it is covered by the coils of the jejunum and ileum; behind, in the iliac fossa, it passes over the psoas, and iliacus, muscles, the branches of the lumbar nerves, except the obturator, the ureter, the spermatic artery and vein. At the brim of the pelvis it curves over the internal and external iliac vessels, and behind and below, are the left common iliac artery and vein.

The **rectum** is the lowest part of the large intestine, and extends from the sigmoid flexure to the anus. It has been divided into three parts: The first part extends from the left sacroiliac joint to the centre of the third piece of the sacrum; the second part, to the tip of the coccyx; and the third part, to the anus.

The rectum is about 8 inches long and somewhat cylindrical in form, narrower above than the sigmoid flexure, but it enlarges as it descends, and just above the anus is remarkably dilated, forming the ampulla. The first part has a mesorectum; the second part is covered by peritoneum in front and laterally; the third part has no peritoneal covering.

The Relations of the Rectum.—Behind, the upper part of the rectum is in relation with the superior hemorrhoidal vessels, the left pyriformis muscle, and left half of the sacral plexus of nerves, which lie between it and the sacrum; its lower part rests on the sacrum, coccyx, and levatores ani muscle, a dense fascia intervening; in front, it is in relation with the posterior surface of the bladder, in the male, and the posterior aspect of the uterus and its left appendages, the coils of the intestines intervening. The extremity of the rectum is in relation in front with the triangular portion of the bladder, the seminal vesicles, the vas deferens, and more anteriorly with the prostate in the male; in the female, with the posterior wall of the vagina.

The cul-de-sac of Douglas (rectovaginal pouch) is the space in front of the rectum and behind the cervix and upper fourth of the vagina. It is formed by the peritoneum reflected over the rectum to the vagina and uterus. In the male it is the space formed between the rectum and bladder, and is called the, **rectovesical space,** or **pouch.**

The Arteries to the Colon.—The ascending colon by the right colic; the hepatic flexure, by the branches of the anastomosing loop formed by the right and middle colic; the transverse colon, by the branches of the anastomosing right, middle, and left colic arteries; the splenic flexure, by the branches derived from the anastomosing loop of the middle and left colic; the descending colon is supplied by branches from the left colic; the sigmoid flexure, by the sigmoid artery. The right and middle colic arteries are derived from the superior mesenteric, the left and sigmoid branches are from the inferior mesenteric artery. **The arteries to the rectum** are the superior hemorrhoidal, a branch of the inferior mesenteric; the middle hemorrhoidal, a branch of the anterior division of the internal iliac, and the inferior hemorrhoidal, from the internal pudic.

The veins of the large intestines correspond to the arteries and open into the portal vein, through the superior and inferior mesenteric veins; the former joins with the splenic to form the portal, the latter opens into the splenic vein. **Veins of the rectum** drain, into the inferior mesenteric, by the superior hemorrhoidal vein, the middle hemorrhoidal, into the internal iliac, and the inferior hemorrhoidal into the internal pudic. These veins form the hemorrhoidal plexus, which communicates with the portal and systemic circulations, the former by means of the inferior mesenteric, receiving the superior hemorrhoidal, and the latter the middle and inferior hemorrhoidal opening into the internal iliac, and internal pudic veins respectively.

The lymphatics of the cecum, ascending and transverse colon drain into the mesenteric nodes; the descending colon and sigmoid flexure into the lumbar nodes. The rectal and anal lymphatics drain into the preaortic nodes. The skin around the margin of the anus is drained by the radicles which pass into the superficial inguinal nodes.

The nerves of the large bowel and rectum are derived from the sympathetic system, the former through the superior mesenteric and inferior mesenteric plexuses, the latter through the superior hemorrhoidal and the pelvic plexuses. The spinal centres for the nerves of the anus and rectum are situated in the first and second sacral segments of the spinal cord. (Gray.)

THE LIVER (HEPAR)

The liver is the largest gland of the body, and fills the entire hypochondrium, the greater portion of the epigastrium, sometimes extending into the left hypochondrium. It weighs from 50 to 60 ounces in the male; 40 to 50 ounces in the female. Constitutes one-eighteenth of the body weight in the adult, and one thirty-sixth of body weight in the fetus. It measures, transversely, from 8 to 9 inches; anteroposterior, 4 to 5 inches, and vertically, near its right surface, about 6 or 7 inches. Its specific gravity is 1.05.

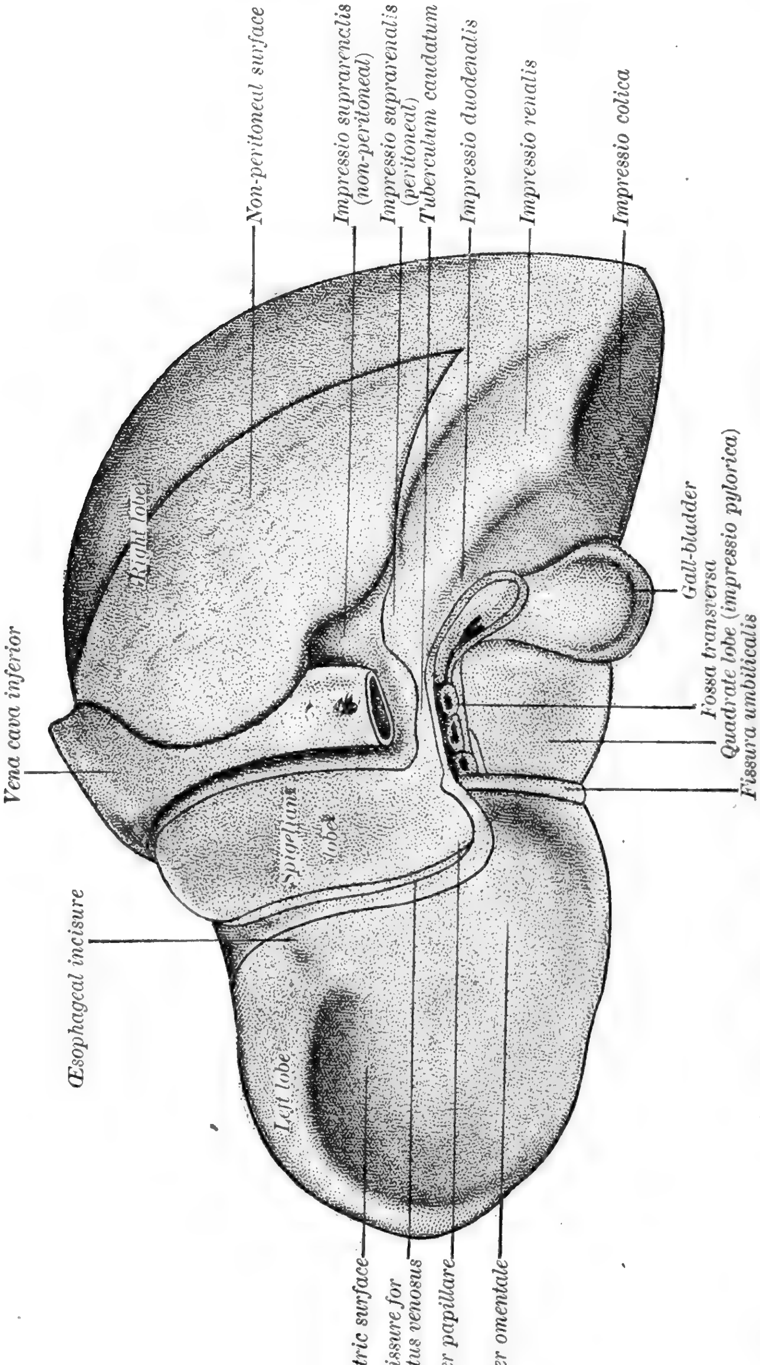
The liver presents a **superior surface**, which includes the right and left lobes; an **inferior surface**, including the right, left, caudate, Spigelian, and quadrate lobes; **anterior** and **posterior surfaces**, comprising the right and left lobes; a **lateral surface** of the right lobe only.

It has an **inferior border**, or **margin**, which is thin and sharp, and notched opposite the falciform ligament, for the round ligament (**umbilical notch**), and opposite the cartilage of the ninth rib by a second notch for the fundus of the gall-bladder.

The left extremity of the inferior margin of the liver is thin and flattened from above downward.

The **ligaments of the liver** are all peritoneal folds excepting the round ligament, which is a fetal remnant of the umbilical vein. The **falciform** ligament (ligamentum falciforme hepatis) is broad and thin, runs from before backward, and is attached above to the diaphragm and the posterior surface of the sheath of the right rectus muscle as far as the umbilicus; below to the superior surface of the liver, from the posterior border to the notch in the anterior border. The free anterior border has between its layers the *round ligament.* It runs along the longitudinal fissure from the umbilicus to the vena cava. The *lateral ligaments* are peritoneal folds which extend between the diaphragm and the corresponding borders of the liver, the left being to the left of the esophageal opening. The *coronary ligament* is a process of peritoneum which is reflected

Fig. 70



The liver. Posterior and inferior surfaces. (Drawn from His' models.)

to the posterior surface of the liver in the situation of its apposition with the diaphragm. It is continuous with the lateral ligaments on each side and with the suspensory in front.

The **fissures of the liver** are five. The *longitudinal* separates the right and left lobes. It is joined by the transverse fissure, or fossa, the part in front of that point being called the *umbilical fissure,* and lodging the umbilical vein or its remains, the round ligament. The *fissure of the ductus venosus* is the part of the longitudinal fissure behind the transverse. It lodges the ductus venosus or its remains. The *transverse* or *fossa* or *portal fissure* is the point of exit and entrance of the vessels, nerves, and ducts. It lies between the quadrate and Spigelian lobes. The fissure for the gall-bladder is on the under surface of the right lobe, parallel to the longitudinal fissure, separated from it by the quadrate lobe. The *fissure for the inferior vena cava,* sometimes a complete canal, lies to the right of the Spigelian lobule.

The **lobes of the liver** are also five in number. The *right* is the largest, being six times as large as the left, and is separated from the left by the suspensory ligament and longitudinal fissure respectively, and in front by the interlobar notch. Its under surface is marked by the transverse fissure and that of the gall-bladder, and its posterior surface by that of the inferior vena cava, and anteriorly is the impressio colica for the hepatic flexure, behind another, the impressio renalis, for the right kidney, and just to the right of the neck of the gall-bladder, the impressio duodenalis. The *left lobe* is flattened, lies in the epigastrium, and is in relation below with the stomach. The *lobus quadratus* is on the under surface of the right lobe, and is bounded in front by the free surface of the liver, behind by the transverse fissure, on the right by the fissure for the gall-bladder, on the left by the umbilical fissure. The *Spigelian lobe* lies behind and above the preceding, and is bounded in front by the transverse fissure, on the right by the fissure of the vena cava, and on the left by the fissure for the ductus venosus. The *caudate lobe,* or *tuberculum caudatum,* runs outward from the base of the Spigelian lobe to the under surface of the right lobe, lying between the transverse fissure and that for the inferior vena cava.

The Structure of the Liver.—It is covered by a serous layer derived from the peritoneum, except the posterior surface for about 3 inches, included between the reflections of the coronary ligaments. Beneath this serous covering is a fibrous or areolar capsule (**capsule of Glisson**), which passes into the transverse fissure around the vessels and blends with the areolar tissue which holds the liver lobules together.

The **vessels of the liver** are:

The *hepatic artery* and *portal vein*, with nerves and lymphatics, pass to, and the *hepatic ducts* pass out from, the transverse fissure. These are all situated between the layers of the lesser omentum, lying in the following relative position: The duct to the right, the artery to the left, and the vein between them and on a posterior plane. They are all enclosed in some loose areolar tissue. The hepatic artery is derived from the celiac axis, and divides into a right and left branch. Entering the transverse fissure they pass between the lobules (**interlobular branches**), and give off small twigs which pass into the lobules and end in the capillary plexus between the cells.

The portal vein divides into interlobular veins, then form a plexus, which gives off intralobular capillaries, ramifying around and in the cells. Thus bringing the blood directly in relation with the cells to form the bile. The hepatic veins are three large trunks, opening into the **inferior vena cava. The ducts** start as minute passages between the cells (**biliary passages, bile capillaries**), then radiating to the circumference of the lobules empty into small **interlobular ducts.** These pass into the portal canals and form two large ducts, a right and left, which accompany the hepatic arteries and portal vein to the transverse fissure of the liver, to become the single **hepatic duct. The nerves of the liver** are derived from the left vagus and sympathetic system.

The lymphatics end in the **celiac group,** some to the **hepatic nodes** at the transverse fissure, and the efferents from the nodes beneath the capsule of Glisson, pierce the diaphragm to empty into the nodes about the inferior cava. A few pass to the nodes about the abdominal portion of the esophagus.

THE GALL-BLADDER

This is a pear-shaped sac lying in the impression of the right lobe, from the right end of the transverse fissure to the anterior free margin. It is 4 inches long and 1½ inches broad, holding 8 to 12 drams, and is held in place by areolar tissue and the peritoneum. The fundus looks downward, forward, and to the right; the body and neck upward, backward, and to the left. Its **relations** are as follows: Above, liver; below, ascending duodenum, pyloric end of stomach, hepatic flexure of colon; in front, abdominal wall (ninth or tenth costal cartilages). The *hepatic duct* is formed by the junction at an obtuse angle of a branch from each lobe, and runs downward and to the right for nearly 2 inches, and joins the cystic duct to form the common bile duct. The *cystic duct* is $1\frac{1}{2}$ inches long, and descends toward the left and joins the above as described. The *common bile duct* is nearly 3 inches long and 3 lines in diameter. It runs along the right border of the lesser omentum behind the first part of the duodenum, and between the pancreas and descending duodenum, then to the right of the pancreatic duct, with which it opens by a common orifice (ampulla of Vater) at the summit of a papilla just below the middle of the inner wall of the second portion of the duodenum. The cystic artery and vein comprise the blood supply.

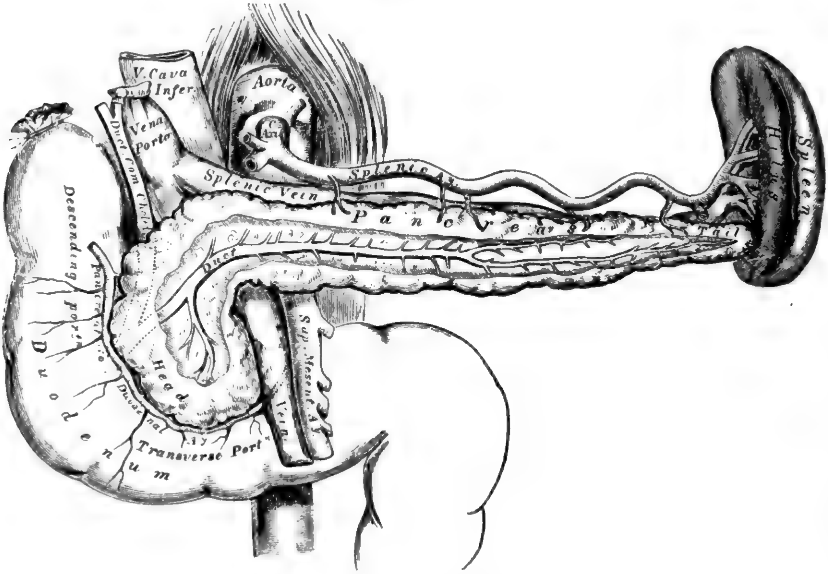
THE PANCREAS

The pancreas is a compound racemose gland, of a reddish-white color. Situated at the back of the epigastrium and left hypochondrium; connected to the posterior abdominal wall by connected tissue and lies retroperitoneal. It is 5 to 6 inches long; its breadth is $1\frac{1}{2}$ inches; its thickness $\frac{1}{2}$ to 1 inch, being greater at its right extremity and upper border. The pancreas is divided into a **head**, a **neck**, a **body**, and a **tail**.

The Relations of the Pancreas.—**The head** is flattened from before backward, and is lodged within the curve of the duodenum. Above, is the first portion of the duodenum and the gastroduodenal artery and vein; below, it overlaps the third portion of the duodenum; in front, in the groove between the right lateral and lower borders, are the anastomosing pancreaticoduodenal arteries, the transverse colon and inferior layer of the transverse mesocolon, and coils of intestines. The **uncinate process** has passing over it the superior mesenteric vessels, the vein lying to the right of the artery. Behind, is the inferior vena cava, the renal vein and artery, the right crus of the diaphragm, the vena azygos major vein, the thoracic duct, and the junction of the splenic and superior mesenteric veins to form the **portal vein,** near the upper border. To the right is the second portion of the duodenum, which it overlaps, and the common bile duct; to the left it passes behind the fourth portion of the duodenum.

The neck is about 1 inch long, flattened from before backward. Its anterosuperior border is in relation with the pylorus; the posteroinferior surface, the commencement of the portal vein.

Fig. 71



The pancreas and its relations. (Gray.)

The Body.—In front the anterior surface is in relation with the posterior inferior surface of the stomach, the lesser peritoneal sac intervening. The posterior surface is devoid of peritoneum, and rests on the aorta, the left kidney and its vessels, suprarenal gland, splenic vein, near its upper border, the crura of the diaphragm, and the origin of the superior mesenteric artery, the inferior mesenteric vein, as it passes up to open into the splenic vein. Below the inferior surface is the duodenojejunal fold, and to the left the splenic flexure of the colon. The superior border is in relation with the celiac axis, its hepatic branch to the right, and splenic artery on the left side. The inferior border has emerging beneath it from above downward the superior mesenteric vessels; from below upward the inferior mesenteric vein. The anterior border gives attachment to the transverse mesocolon.

The tail is in relation with the spleen and the splenic flexure of the colon.

The duct of the pancreas is called the **pancreatic duct,** or **canal of Wirsung.** It extends transversely through the substance of the gland to drain the lobules by means of small ducts, which open into it. Increasing in size it reaches the neck, passes downward, backward, and obliquely to the right, piercing the muscular and mucous coat of the second portion of the duodenum where it opens into the **ampulla of Vater,** common to it and the **bile duct**; the latter opens into the canal of the duodenum.

The arteries of the pancreas are the superior pancreaticoduodenal, a branch of the gastroduodenal; the inferior pancreaticoduodenal, a branch of the superior mesenteric; small and large pancreatic arteries, branches of the splenic. **The veins** are: The inferior pancreaticoduodenal, opening into the superior mesenteric and superior pancreaticoduodenal draining into the gastroduodenal vein, and the pancreatic veins draining the body and tail pass to the splenic. **The nerves** are derived from the celiac, superior mesenteric, and splenic plexuses. **The lymphatics** empty into the splenic, preaortic (Sappey), superior mesenteric, and pancreaticoduodenal nodes.

The pancreas lies in front of the second lumbar vertebra. When the stomach and colon are empty it can be felt about 3 inches above the umbilicus.

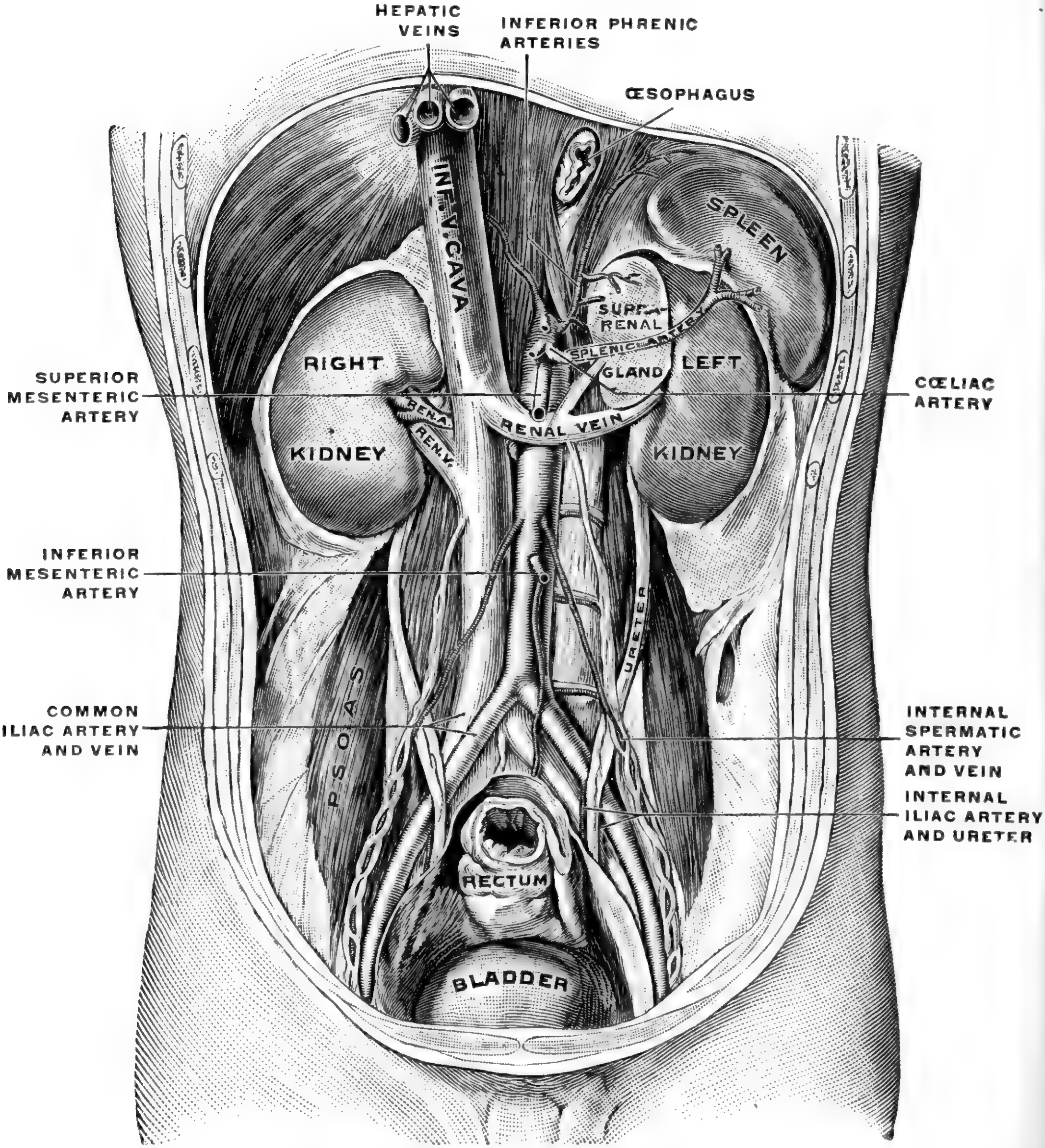
THE URINARY ORGANS

The urinary organs include the **kidneys,** which secrete the urine; the **ureters** convey it to the **bladder,** where it is retained until voided; then the **urethra,** which discharges it from the body.

THE KIDNEYS (RENES)

The **kidneys** are situated on each side of the vertebral column, resting on the psoas magnus and the quadratus lumborum muscles. They are retroperitoneal and correspond to the space included between the upper level of the twelfth thoracic

Fig. 72



Posterior abdominal wall, after removal of the peritoneum, showing kidneys, suprarenal capsules, and great vessels. (Corning.)

above, and opposite the third lumbar vertebra below. The right kidney is lower than the left. In the female they are a little lower than in the male.

Each is bean-shaped, measures about 4 to $4\frac{1}{2}$ inches in length, $2\frac{1}{2}$ in breadth, and 1 to $1\frac{1}{2}$ inches in thickness, and weighs about 4 to 6 ounces. They lie in the right and left hypochondrium, the epigastrium, and the right and left lumbar regions.

The **anterior surface** of the kidney is convex and looks forward and somewhat outward.

The **posterior surface** is flatter than the anterior and is embedded in fatty areolar tissue.

The **external border** is convex, directed outward and backward.

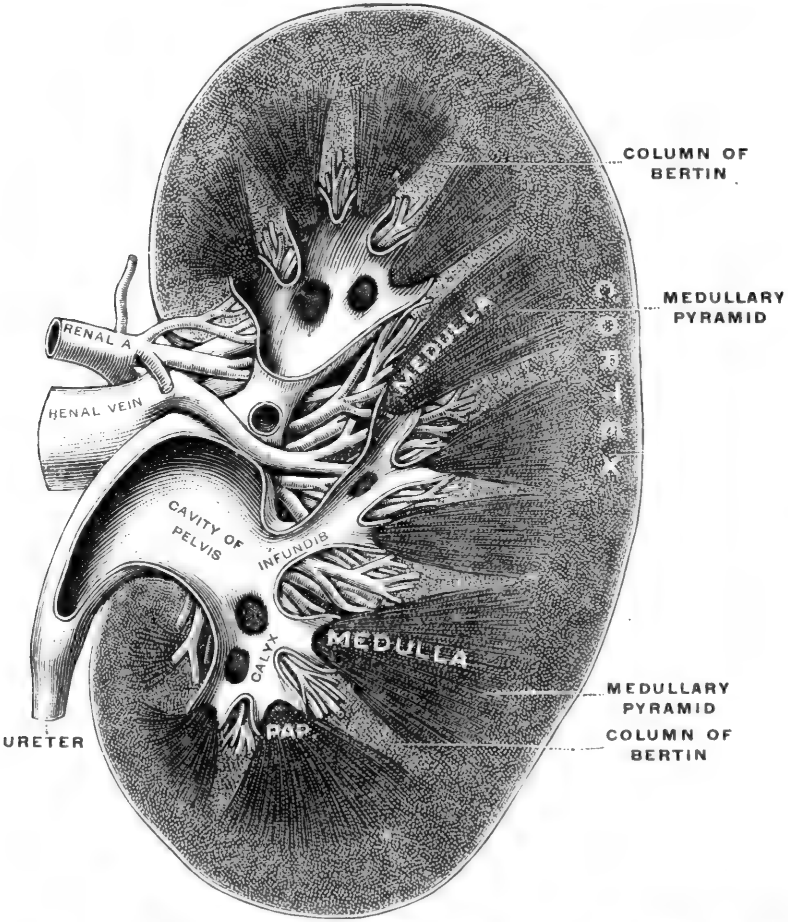
The **internal border** is concave, directed forward and a little downward, and presents a deep longitudinal fissure, the hilum, for the passage of vessels and nerves.

The **superior extremity** is directed upward and slightly inward, is thick and rounded, supporting the suprarenal capsule.

The **inferior extremity** is directed downward and slightly outward. It is smaller and thinner than the upper, and extends down to within about two inches of the iliac crest.

The **relations of the right kidney** are in front, about three-fourths of its surface rests in the impressio renalis of the inferior surface of the right lobe of the liver; internally with the second portion of the duodenum; the lower part is covered by the ascending colon; the small intestines are also in relation. Behind it rests on the psoas, the quadratus lumborum, the transversalis muscles, the crus of the diaphragm, the anterior layer of the lumbar aponeurosis, the internal and external arcuate ligaments, the lumbocostal ligaments, the last thoracic and first lumbar nerves. The twelfth rib makes an impression in the right kidney. Externally, its outer border rests on the abdominal wall. Internally, the renal vessels and ureter, and the inferior vena cava. Above, it is capped by the suprarenal gland. Below, it extends to within 2 inches of the crest of the ilium. The **left kidney**, in front, is covered along the upper part by the suprarenal gland, the renal impression of the spleen near its outer border, the body of the pancreas overlies its middle area, and between the splenic and pancreatic relation is a small space in contact with the posteroinferior surface of the stomach, also the descending colon and the intestines touch it. The lesser peritoneal sac extends over the left kidney and suprarenal. The external border is in relation with the spleen above. The posterior, internal, superior relations are the same as the right kidney, except that posteriorly it

FIG. 73



Vertical section of kidney, showing the secreting portion, the vessels, and the beginnings of the ureter. (Testut.)

is grooved by the eleventh and twelfth ribs. The areas in relation with the liver, the spleen, and intestines are covered by peritoneum.

Fixation of the Kidney.—The kidney is embedded in a mass of fatty tissue (**capsule adiposa**) surrounded by a fibrous sheath named the **fascia renalis,** continuous with the subperitoneal fascia. Its anterior portion passes inward over the renal vessels, and blends with the same layer from the opposite side. Its posterior layer passes behind and fuses with the fascia over the quadratus lumborum and psoas muscles; passing to the vertebral column. At the upper extremity the two layers fuse with the fascia of the diaphragm. Below they remain separate and are lost on the subperitoneal fascia of the iliac fossa. The fascia renalis is attached to the kidney capsule by numerous trabeculæ. Behind the fascia renalis is the **pararenal fat,** or **body.** The kidney is held also by the attachments to adjoining viscera, by the means of peritoneal folds or ligaments, as the **lienorenal** ligament.

The renal arteries divide into three or four branches before entering the hilum. They give off a branch to the suprarenal gland, the ureter, and surrounding muscles. The arteries lie behind the vein and in front of the ureter. The left renal vein receives the left phrenic and spermatic veins and opens into the inferior vena cava.

The nerves of the kidney are derived from the sympathetic through the renal plexus.

The lymphatics drain from three locations: From the perirenal fat, which drains directly into the upper lateral aortic nodes; from beneath the capsule, which joins at the hilum with the third set, from the substance of the kidney, and pass along the renal vessels to empty into the lateral aortic nodes. The subcapsular and perirenal lymphatics communicate freely with each other.

THE URETERS

The **ureters** are two in number and convey the urine from the kidney to the bladder. The urine is collected from several **minor calices,** ten to twenty in number, which open into the **major calices,** the latter by their junction form the pelvis, or dilated portion of the ureter. It is on a line with the first lumbar vertebra.

The *ureter* proper is divided into an **abdominal portion** (pars abdominalis) and a **pelvic portion** (pars pelvina). They are 10 to 12 inches in length and $\frac{1}{6}$ of an inch in diameter. The walls are from 1 to 2 mm. thick. It has 4 main constrictions: (1) At the junction with its pelvis; (2) as it passes over the brim of the pelvis; (3) as it enters the bladder; (4) at its termination.

Relations of the Right Ureter (Abdominal Portion).—It is retroperitoneal, and lies on the psoas magnus muscle and crosses the genitocrural nerve. The spermatic artery or ovarian passes over it from within outward; the spermatic vein from without inward. At its origin it lies behind the second portion of the duodenum, the right colic vessels, and near the brim of the pelvis, the end of the ileum. It crosses the common iliac artery at its bifurcation into the internal and external iliac at the brim of the pelvis.

The Pelvic Portion.—It lies on the lateral wall of the pelvis, behind the peritoneum; in front of the internal iliac vessels; passing downward and forward it enters the bladder, piercing the wall and within which it runs for about $\frac{3}{4}$ of an inch to terminate in a slit-like aperture into the cavity of the bladder. When the bladder is distended, the ureters are two inches apart; when empty, about one inch nearer each other. It is crossed in front by the vas deferens, in the male, which passes downward, backward, and inward on a level with the upper margin of the seminal vesicle. In the female it lies behind the ovarian fossa, forming its posterior boundary. Passes forward and inward, on a line with the cervix of the uterus, lying $\frac{3}{4}$ of an inch external. It is accompanied for about 1 inch by the uterine artery, a branch of the anterior division of the internal iliac. The uterine artery crosses above the ureter from without inward to ascend between the two layers of the broad ligament.

The relations of the left ureter are the same as the right side, except that the sigmoid flexure of the colon passes over it, in front, at the lower part of the abdominal portion.

The **arteries** are derived from the renal, spermatic, internal iliac, and inferior vesicle. The **veins** correspond to the arteries. The **nerves** are filaments from the inferior mesenteric, spermatic, and pelvis plexuses. The **lymphatics**, upper portion, drain into the efferent branches from the kidney; the abdominal portion, into the lateral aortics; near the pelvis, the common iliac nodes; and within the pelvis, the internal iliac nodes.

THE URINARY BLADDER (VESICA URINARIS)

The bladder is situated in the pelvic cavity, but in infancy and when distended in the adult, extends into the hypogastrium. It measures when moderately distended 5 to $5\frac{1}{2}$ inches in length, $4\frac{1}{2}$ in width, and 3 inches from before backward. It holds a pint of urine without discomfort. The bladder presents a superior, anteroinferior, and two lateral surfaces; a base or fundus, and an apex, or summit.

The **interior of the bladder** shows the mucous membrane thrown into **rugæ,** the **orifices** of the **ureters,** and the **trigone.** The ureteral orifices are about 2 inches apart, when the bladder is moderately distended. The **trigone,** or **trigonum vesical,** is a smooth, triangular surface, paler than the rest of the mucous membrane. It is bounded at the basal angles to the orifices of the ureters, and the apex to the urethral orifice. The **ureteral folds** are the prolongations extending beyond the ureteral orifices, of the transverse ureteral fold containing muscle fibers covered by the mucous membrane. The urethral openings are surrounded by a circular fold of mucous membrane, called the **annulus urethralis.**

The **ligaments** of the bladder are **true and false.** The true are the two anterior, two lateral, and the urachus. The false are five, and consist of folds of peritoneum.

The **two anterior true** or **puboprostatic ligaments** extend from back of the pubic bone, one on each side of the symphysis, to the front of the neck of the bladder, over the anterior surface of the prostate gland. The **two lateral true** ligaments arise from the pelvic wall, being formed by the pelvic fascia, (rectovesical fascia), and are inserted into the sides of the base of the bladder and the lateral surfaces of the prostate gland. The **urachus** is the impervious remains of the **allantois,** an embryological structure, which helped to form the bladder. It is attached to the apex of the bladder and passes to the umbilicus, between the transversalis fascia and peritoneum, forming the **plica umbilicalis media.** The **two posterior false** ligaments are folds of peritoneum, passing from the sides of the rectum, in the male to the outer and posterior aspect of the bladder (the rectovesical folds); in the female these folds are called (the vesicouterine folds) and pass from the sides of the uterus to the lateral and posterior aspect of the bladder; they form in the male the lateral boundaries of the **rectovesical pouch**; in the female, the lateral boundaries of the **rectovaginal pouch,** or **cul-de-sac of Douglas.** The **two lateral false ligaments** and the **superior false ligaments** are folds of peritoneum reflected from the walls of the pelvis, on to the obliterated hypogastric arteries, and the urachus respectively.

The Relations of the Bladder.—The superior surface is covered by peritoneum and is in relation with the uterus in the female, the intestines, and sometimes the sigmoid flexure of the colon. Near its posterior aspect the vas deferens is in contact with it. When the bladder is relaxed, this surface shows a transverse fold of peritoneum, called the plica vesicalis transversa. The **anteroinferior surface** is devoid of peritoneum, when empty, and lies in relation with the obturator internus muscles, the puboprostatic ligaments and rectovesical fascia. When distended the upper part of this surface is covered by peritoneum. Between the bladder and the pubes is a triangular space, containing areolar and adipose tissue, called the **pubovesical,** or **space of Retzius.** During distention this space is increased, and the anterior-inferior surface lies in contact with the abdominal wall. The **lateral surfaces** are covered by peritoneum behind and above, the impervious hypogastric arteries, below, and in front of these, the bladder is uncovered by peritoneum and is separated from the pelvic walls and levatores ani muscles by areola tissue and contained fat. The vas deferens crosses the ureter and lies between it and the posterior portion of this surface. When the bladder is empty, the peritoneum sinks down to the sides of the bladder and form the **paravesical fossæ.** The **fundus** is covered by peritoneum to within $1\frac{1}{2}$ inches of the prostate gland, and forms the anterior boundary of the rectovesical and vesicouterine pouches in the male and female respectively. Below the reflection of peritoneum, the bladder is in relation with the second portion of the rectum, the seminal vesicles, and the vasa deferentia. The ureters open into the fundus, about $1\frac{1}{2}$ inches above the base of the prostate gland. The **neck** is the commencement of the urethra, and is surrounded by the prostate gland. The **apex,** when empty, is on a level with the upper border of the symphysis pubis.

The arteries are derived from the superior, middle, and inferior vesical branches of the anterior division of the internal iliac, with additional branches from the uterine and vaginal in the female. The **veins** drain into the prostatic plexus around the neck and sides of the bladder, and then pass to the internal iliac veins.

The **nerves** are branches from the pelvic plexus of the sympathetic system, and the third and fourth sacral nerves.

The Lymphatics.—The lymphatics from the anterior surface pass to the **external iliac** nodes; the posterior surface to the **internal iliac** and **hypogastric** nodes, and a few nodes at the promontory of the sacrum.

THE ORGANS OF REPRODUCTION (MALE)

THE PROSTATE GLAND

The prostate gland is immediately in front of the so-called neck of the bladder and around the commencement of the urethra. It rests against the rectum behind, and lies on the subpubic fascia (posterior layer of triangular ligament). It resembles a chestnut in form, and measures transversely $1\frac{1}{2}$ inches, from base to apex $1\frac{1}{4}$ inches, and nearly 1 inch in thickness, its weight being 6 drams. The *base* looks toward the neck of the bladder, its *apex* touches the deep perineal fascia (triangular ligament), the *posterior surface* is joined to the rectum by areolar tissue, and its *pubic surface*, grooved longitudinally, lies $\frac{3}{4}$ inch from the pubic symphysis. It is supported in its position by the puboprostatic ligaments, posterior layer of the deep perineal fascia, and the front of each levator ani (the levator prostatæ).

The prostate consists of two lateral lobes and a middle lobe. The *lateral lobes* are separated behind by a deep notch, and are continuous in front of the urethra. The *middle* is smaller, lying posteriorly between the lateral lobes.

The urethra and common seminal ducts pierce the prostate. The gland has a dense, firm, fibrous capsule, which is derived from the rectovesical fascia and the posterior layer of the triangular ligament, and it consists of glandular and muscular tissue in about equal amounts.

THE PENIS

The penis consists of a root, a body, and an extremity, or glans penis.

The **body** is made up of three cylindrical masses of erectile tissue united together, the two upper of which, lying side by side and called the corpora cavernosa, form the chief bulk of the organ, and the lower, the corpus spongiosum, contains part of the urethra.

The *root* is attached to the pubic rami by the crura, and to the symphysis by the suspensory ligament.

The *body* is cylindrical when flaccid, triangular with rounded border and sides when erect, the upper side being the dorsum. It is covered by a very thin skin, which is dark in color and devoid of adipose tissue, being loosely connected to the organ. This skin folds upon itself in front to form the prepuce, the under layer of which joins the cervix and becomes very like a mucous membrane, covering the glans and blending into the mucous membrane of the urethra at the meatus. Around the cervix and corona glandis are small glands, the glandulæ Tysoni odoriferæ.

The *glans* (see Corpus Spongiosum) is conical and points anteriorly, its summit presenting a vertical slit, the *meatus urinarius,* from the lower part of which a fold of mucous membrane runs back to join the prepuce, and is called the *frænum præputii.* The base of the glans projects at its circumference, forming the *corona glandis,* behind which is a constriction, the *cervix.*

The *corpora cavernosa* are closely connected for the anterior three-fourths, being flattened mesially, while behind they separate, and enlarging at first to form the bulb of the corpus cavernosum, gradually taper, and under the name of *crura penis* are attached to the rami of the pubes and ischium. In front they form a single blunt extremity, which is joined by fibrous tissue to the base of the glans. Below them is a groove for the corpus spongiosum, and above one for the dorsal vein of the penis.

The fibrous envelope is composed of longitudinal fibers common to both corpora, and circular fibers which are internal and belong to one corpus only. Mesially, where the circular fibers of both sides meet, they unite to form a septum. This septum is thick and complete behind, but in front many vertical slits allow of communication between the two bodies, and have given to the septum the name *septum pectiniforme.* From the inner surface of this envelope numerous fibrous trabeculæ pass in all directions. These trabeculæ support and enclose the arterial branches, which form a capillary network opening directly into the cavernous spaces, some of them forming convoluted vessels, the helicine arteries, which project into the trabecular spaces. The blood is returned by the dorsal vein, prostatic plexus, and pudendal veins.

The *corpus spongiosum* commences behind, between the two crura, and in front of the deep perineal fascia, as the *bulb,* and in front expands to form the glans. The bulb receives an investment from the anterior layer of the deep perineal fascia and is surrounded by the accelerator urinæ muscles. The urethra runs through the upper part of the corpus spongiosum, surrounded by a layer of erectile tissue, the part within the bulb being called the bulbous portion of the urethra. The fibrous envelope is white, thinner than that of the corpora cavernosa, and encloses a similar trabecular structure. Just beneath it, forming part of the outer coat, is a layer of muscular fibers, and a second muscular layer lies beneath the urethral mucous membrane.

THE MALE URETHRA

The male urethra extends from the neck of the bladder to the end of the penis, is about $8\frac{1}{2}$ inches long, and is lined throughout by mucous membrane supported by a submucous tissue and connected by it with the subjacent tissues in its three parts, viz., the prostatic, membranous, and spongy. Part of the submucous tissue is composed of a longitudinal muscular layer internally and a circular externally.

The **prostatic portion** is the widest part of the canal, and traverses the prostate gland, being about $1\frac{1}{4}$ inches long, widest at the middle, and lying above the middle lobe. It is very dilatable. On its floor is a slight longitudinal elevation at the back part, which passes back to the uvula vesicæ, and is placed in the median line, measuring $\frac{3}{4}$ inch long and about $\frac{1}{8}$ inch at its maximum height. This ridge has been variously named the crista urethræ, *colliculus seminalis, verumontanum,* and *caput gallinaginis.* On each side of it is a groove, the *prostatic sinus,* the floor of which presents the orifices of the numerous prostatic ducts.

In the forepart of the verumontanum is a depression, which leads into the *sinus pocularis,* or *uterus masculinus,* upon or within the margins of which are the orifices of the *ejaculatory ducts.* This sinus forms a cul-de-sac running in the verumontanum and beneath the middle lobe of the prostate.

The **membranous portion** lies between the apex of the prostate and the bulb of the corpus spongiosum, and is the narrowest part of the canal. It is $\frac{3}{4}$ inch long. It pierces, lies between, and is invested by the anterior and posterior layers of the deep perineal fascia, and is surrounded by the compressor urethræ, one of Cowper's glands lying on each side.

The **spongy portion** of the urethra is enclosed by the corpus spongiosum, and is about $6\frac{1}{2}$ inches long. The *bulbous portion,* or *sinus,* is dilated, but beyond the bulb the urethra is of uniform caliber as far as the glans, in which it is again dilated, forming here the *fossa navicularis,* and its long axis becomes vertical instead of transverse. At the meatus it is much contracted.

The mucous membrane presents the orifices of many small racemose glands (glands of Littre) and of many *lacunæ.* One of these latter, in the upper part of the fossa navicularis, is considerably dilated, and is called the *lacuna magna.*

Cowper's glands are yellowish, lobulated bodies, of the size of a pea, lying between the two layers of the deep perineal fascia, behind the membranous urethra, and between the arteries of the bulb above and the transverse fibers of the compressor urethræ below. The lobules are made up of acini and joined together by fibrous tissue. The ducts from the lobules unite outside the gland into a common duct, which runs forward beneath the mucous membrane for about an inch and opens on the floor of the bulbous portion of the urethra.

THE SCROTUM

The scrotum is a pocket which contains the testicles and part of the spermatic cords, and is marked superficially by a median ridge, the raphé, which runs from the penis along the scrotum and perineum to the anus. The scrotum consists of a layer of skin and the dartos.

The *skin* is thin and dark, and presents folds or rugæ, is covered with hairs thinly scattered, and is furnished with sebaceous glands.

The *dartos* is a thin contractile tunic, of a reddish color, continuous with the superficial fascia of the groin and perineum; it is very vascular, and is composed of loose areolar tissue and unstriped muscle. It sends in a partition, the septum scroti, which separates the two testes, and is attached to the under surface of the penis and to the raphe.

The *testicle* is covered from without inward by the following structures: The scrotum, composed of skin and dartos; the intercolumnar or external spermatic fascia; cremasteric fascia; infundibuliform fascia, or internal spermatic fascia; tunica vaginalis.

The *intercolumnar* fascia, separated by loose areolar tissue from the dartos, is attached to and descends from the margins of the pillars of the external ring.

The *cremasteric* fascia consists of scattered muscular loops or bundles (cremaster muscle), connected together by areolar tissue, the former being continuous with the lower border of the internal oblique.

The *infundibuliform* fascia is continuous above with the fascia transversalis and the subserous areolar tissue of the peritoneum. These two together, the latter being underneath, form the fascia propria. It invests the surface of the cord and sends in septa between its component parts.

The *tunica vaginalis* (see *Testicle* proper).

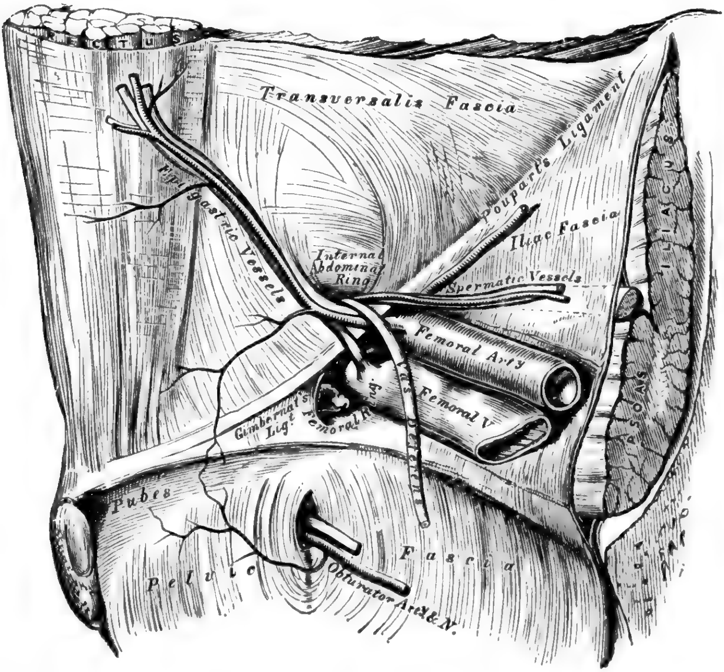
THE TESTICLE AND EPIDIDYMIS

Each **testicle** is ovoid, flattened from side to side, and suspended obliquely (the left being somewhat the lower), its upper end being directed forward, outward, and upward, the lower in the opposite direction. Each is $1\frac{1}{2}$ inches long, $1\frac{1}{4}$ inches wide, and less than 1 inch thick, and weighs $\frac{3}{4}$ to 1 ounce.

The front, sides, and both ends of the testis are free, smooth, and covered by the tunica vaginalis. At the posterior border the vessels and nerves enter and emerge, and to this border as well is attached the epididymis.

The **epididymis** is a long, narrow structure, made up of a *body*, a *head*, or *globus major*, and a *tail*, or *globus minor*.

Fig. 74



Hernia. The relations of the femoral and internal abdominal rings, seen from within the abdomen; right side. (Gray.)

The globus major is large, and joined to the upper end of the testicle by the efferent ducts; the minor is small and pointed, and is joined to the lower end of the testicle by a reflection of the tunica vaginalis and some cellular tissue. The convex surface and anterior border of the epididymis are free and covered by the tunica vaginalis, as is also the concave or attached surface (except at the ends), the serous membrane here forming the *digital fossa.* On the front of the globus major are one or more small pedunculated bodies called the *hydatids of Morgagni,* believed to be the remains of Müller's duct. The epididymis is a convoluted canal whose lumen is continuous with that of the vas deferens.

The **tunica vaginalis** is a closed serous sac, and consists of a visceral layer and a parietal layer.

The *visceral layer* adheres to the outer surface of the tunica albuginea, surrounding the testis and epididymis, and joining them together by a fold. It forms between them the pouch known as the digital fossa.

The *parietal layer* is reflected to the inner surface of the scrotum at the posterior border of the testicle.

The **tunica albuginea** is the fibrous coat which surrounds the soft substance of the testis and is reflected at the posterior border into its interior, forming a sort of septum, the *corpus Highmori* or *mediastinum testis.* This septum, wider above than below, extends from the upper nearly to the lower end of the gland, and sends off numerous trabeculæ which join the inner surface of the tunica albuginea. These divide the organ incompletely into *lobules.* The *tunica vasculosa* (pia mater testis) is a vascular plexus supported by areolar tissue which covers the inner surface of the tunica albuginea and its trabeculæ.

The **gland substance** consists of *seminiferous tubules,* which are contained within the lobules above mentioned, each lobule containing two or three seminiferous tubules. Each of these latter is lined by several layers of epithelial cells, from which, by a process of division (karyokinesis), are finally developed the spermatozoa.

The *lobules* are conical, their bases being turned toward the circumference, their apices toward the mediastinum. In the latter situation the tubules become straighter, and unite to form twenty to thirty large ducts, the *tubuli recti.* These *tubuli recti* open into a vascular network, the *rete testis,* which lies in the substance of the mediastinum, and from this issue twelve to twenty *vasa efferentia,* which pierce the tunica albuginea and enter the globus major of the epididymis, where they now become tortuous and form conical masses, the *coni vasculosi.*

The **vas deferens,** the continuation of the epididymis, is the excretory duct of the testicle. From the globus minor it runs along the inner side of the epididymis and back of the testis, and in the spermatic cord to the internal ring; here it descends, crossing the external iliac vessels, and curving around the outer side of the deep epigastric artery. It now passes beneath the peritoneum to the side of the bladder, and runs downward, backward, and inward to its base, internal to the ureter and across the obliterated hypogastric artery. At the base of the bladder it lies between it and the rectum, internal to the seminal vesicle, the duct of which it joins (close to the base of the prostate), after having enlarged and again narrowed, forming with it the ejaculatory duct. Its length is about 2 feet and its diameter about $\frac{1}{10}$ inch. It has an external areolar coat, a middle muscular coat of two layers, longitudinal and circular, and an internal mucous coat covered with columnar epithelium.

The **vesiculæ seminales**, conical in form, the wider end looking backward, lie between the rectum and the base of the bladder, and are the reservoirs for the semen. They are 2 inches long and $\frac{1}{2}$ inch wide. In front they converge, and each joins the corresponding vas deferens at the base of the prostate to form the ejaculatory duct. The vesicle is a single tube 4 to 6 inches long, coiled up and giving off diverticula. It ends behind in a blind extremity, and is 2 inches long in its natural condition.

Each **ejaculatory duct** is $\frac{3}{4}$ inch long, and runs, one on each side, forward and upward within the prostate, between its middle and lateral lobes, and along the walls of the sinus pocularis, close to the opening of which they empty. Each has an areolar, a muscular, and a mucous coat.

The **semen** is a whitish fluid composed of liquor seminis, seminal granules, and spermatozoa. The granules are $\frac{1}{4000}$ inch in diameter. The spermatozoa consist of a head, formerly the nucleus of a spermatoblast, a body, and a tail. The spermatoblasts constitute one of the layers of epithelial cells lining the seminiferous tubules.

The **spermatic cord** extends from the internal ring to the back of the testis. Its various parts are connected together by areolar tissue, and are invested by the various processes of the fascia, which descends with the testicle. In its course through the inguinal canal it lies at first between the internal oblique and the fascia transversalis, the former at times arching over it; then between the aponeurosis of the external oblique and the conjoined tendon; and Poupart's ligament is below. The left cord is the longer.

Each cord is composed of the spermatic artery, artery of the vas deferens, and cremasteric artery, the spermatic veins from the back of the testis, which receive the veins from the epididymis to form the pampiniform plexus, a number of large lymphatics, and the spermatic plexus of the sympathetic, together with the vas deferens, the layers of fascia which cover the testicle, and the remains of the peritoneal testicular process.

The **inguinal canal** (see p. 189 for description) is bounded *behind* by the fascia transversalis and the conjoined tendon; *in front* by the transversalis and internal oblique above, and the external oblique aponeurosis below; its floor is formed by the curving back of Poupart's ligament; its roof by the arched fibers of the internal oblique in apposition with the aponeurosis of the external oblique.

THE EXTERNAL ORGANS OF REPRODUCTION (FEMALE)

THE VULVA

The term *vulva*, or *pudendum*, includes the mons veneris and labia, the nymphæ and clitoris, the hymen or its remains, the meatus urinarius, and the vaginal orifice.

The **mons veneris** is a fatty cushion covering the front of the pubes, and after puberty is plentifully supplied with hairs. Below, it divides into the two **labia majora**, which, diminishing in size as they pass downward and backward, unite an inch in front of the anus. The two extremities are joined, and form the anterior and posterior commissures. Between the latter and the anus is the perineum, and just within the posterior commissure is a transverse fold, the frænulum pudendi, or fourchette. Between this fold and the posterior commissure is a triangular space, the fossa navicularis.

The **nymphæ**, or labia minora, smaller than the above, run from the middle of the labia majora upward to the clitoris, each dividing into two folds, the upper pair of which join to form a prepuce for that organ, and the lower two to form its frenum. They are continuous externally with the labia majora, internally with the vagina. The mons veneris is composed interiorly of fatty and fibrous tissue; the labia, of areolar fatty and dartoid tissue with vessels and nerves; the nymphæ, of a plexus of vessels covered by mucous membrane.

The **clitoris** is the analogue of the penis, consisting, like it, of two corpora cavernosa united by a septum pectiniforme and prolonged behind into two crura attached to the pubic and ischial rami. It also has a suspensory ligament and a glans enclosed by the nymphæ. Two erectores clitoridis muscles are attached to the crura. It has no corpus spongiosum or urethra.

Between the clitoris and the vagina, bounded on each side by the nymphæ, is the **vestibule**, a triangular space, in which, just above the vagina, is the meatus urinarius, one inch below the clitoris.

The **hymen** is a mucous fold which more or less completely occludes the orificium vaginæ. It is generally semilunar in form, concave above, or it may be a complete membrane, perforate or imperforate, or it may be absent. After labor its remains form the carunculæ myrtiformes.

The **glands of Bartholin**, the analogues of Cowper's glands in the male, are two yellowish bodies on each side of the vaginal opening, each of which discharges by a single duct between the hymen and the nymphæ.

On each side of the vestibule, behind the nymphæ, is a leech-shaped mass, the **bulbus vestibuli.** Each consists of a venous plexus enclosed by a fibrous capsule, and is about one inch long. In front of these, and connecting them with the vessels of the clitoris, is a small venous plexus, the *pars intermedia* of Kobelt.

THE URETHRA

The *female urethra* is a mucous canal, $1\frac{1}{2}$ inches long, running downward and forward in the anterior vaginal wall from the neck of the bladder to the meatus. As in the male, it pierces the triangular ligament, and is surrounded by the compressor urethræ muscle. It consists of a muscular, a mucous, and between them an erectile coat. It is supplied with numerous glands, and just within the meatus near the floor are two ducts which extend upward for about $\frac{3}{4}$ inch. These are called Skene's tubules.

THE VAGINA

The *vagina* extends from the vulva to the uterus, lying behind the bladder and in front of the rectum, and is about 4 inches long on its anterior wall, 5 to $5\frac{1}{2}$ on its posterior, and is directed from the uterus downward and forward.

Above, it embraces the cervix uteri, and its walls are flattened from before backward. It is narrowest at the introitus, or orificium vaginæ. *In front* it is in relation with the urethra and base of the bladder; *behind,* it is connected with the anterior wall of the rectum by its lower three-fourths, the cul-de-sac of peritoneum (Douglas') separating them above; *laterally,* the broad ligaments are attached above, and the levatores ani below, as well as the rectovesical fascia. Its inner surface presents a mesial ridge or raphé on the front and back walls, the columnæ rugarum, and from them on both sides run out transverse folds or rugæ.

The vaginal mucous membrane is squamous, with papillæ here and there. The submucous coat holds many large veins and some muscular fibers, making a sort of erectile tissue. The veins form a sort of plexus. The muscular coat comprises an internal circular and an external longitudinal layer. At the lower part is the sphincter vaginæ, a muscle composed of striped fibers.

The *internal organs* include the *uterus, tubes,* and *ovaries.*

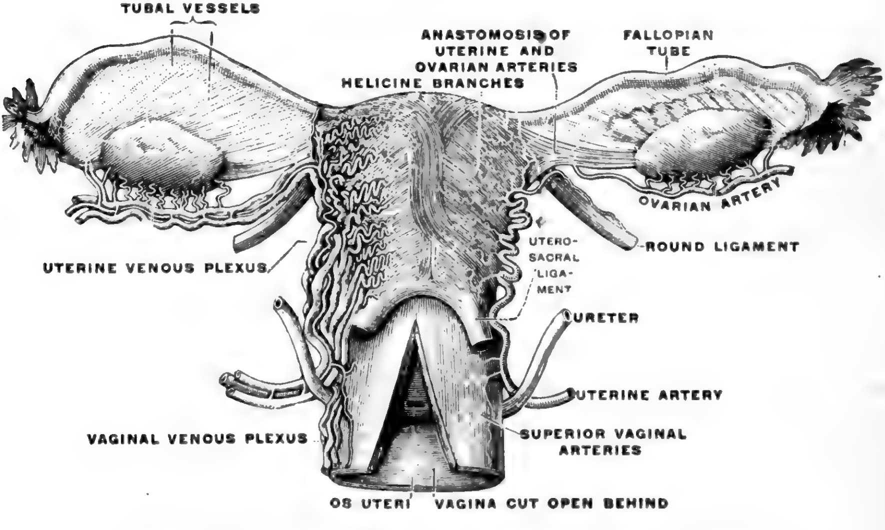
THE INTERNAL ORGANS OF REPRODUCTION (FEMALE)

THE UTERUS

The **uterus,** or **womb,** is a hollow muscular organ lying in the pelvis between the bladder and rectum. In the virgin it is pear-shaped, flattened from before backward, its upper end looking forward and upward, its lower downward and backward, forming an angle with the vagina. Above, it is invested by the peritoneum, which covers its body before and behind; it covers also the cervix behind, but in front the peritoneum is reflected on to the bladder before reaching the cervix. Its upper and back part is in contact with the small intestine, its lower and front part with the bladder, the peritoneum separating them. The two folds of peritoneum after investing the uterus are applied to each other, reaching across to the lateral pelvic walls forming the broad ligaments.

The uterus is 3 inches long, 2 wide, and 1 thick, and it weighs about 1 ounce. It is divided into a body, fundus, and neck. The **fundus** is the convex part above the entrance of the tubes; the **body** is the part between this and the neck. In front of

Fig. 75



Vessels of the uterus and its appendages, rear view. (Testut.)

the Fallopian tubes, at the upper part of the lateral borders, the round ligaments are attached, and below and behind them are the ligamenta ovarica. The **cervix** is the lower constricted, rounded part, and around it is attached the vagina. At its vaginal end is a round opening, the os uteri.

The **cavity** of the uterus is small; that part within the body is triangular, flattened anteroposteriorly, and presents at the superior angles the openings of the Fallopian tubes; also, at its junction with the neck it is constricted to form the os internum or isthmus. The cavity of the cervix is barrel-shaped and flattened anteroposteriorly, presenting on each wall a longitudinal column sending off oblique rugæ on each side; hence its name, arbor vitæ uterinus.

The **walls** of the uterus consist of an outer serous coat (already described), an inner mucous, and an intermediate muscular. The muscular coat forms the bulk of the uterus, and consists of bundles and layers of unstriped fibers which interlace, and of some areolar tissue supporting them, and of bloodvessels, lymphatics, and nerves. Three layers are described—an external transverse layer, some of the fibers being continued on to the Fallopian tubes, etc.; a middle layer of intermixed longitudinal, oblique, and transverse fibers; and an internal layer, which is circularly arranged at the cervix, forming the so-called external and internal sphincters. This layer is the muscularis mucosæ of the mucous membrane.

The **mucous membrane** of the *body* differs from that of the cervix. The former is smooth, reddish, with columnar cells, and presents the ducts of a number of tubular glands which end by blind, sometimes forked, extremities. In the *cervix* it is firmer, and presents numerous saccular and tubular glands between the rugæ of the arbor vitæ, and below, numerous papillæ. The glands are sometimes distended by their secretion, the ducts being choked, and present the appearance of vesicles; hence their name, ovules of Naboth. At the upper part of the cervix the cells are columnar and ciliated; below, stratified.

The **ligaments** of the uterus are the *round* ligaments and several *peritoneal folds,* namely, two each in front, behind, and laterally.

The *round ligaments* are two cord-like bundles of areolar, fibrous, and plain muscular tissue, with vessels and nerves, covered by peritoneum, which run from the upper angle of the uterus to the internal ring. Each then runs through the corresponding inguinal canal to end in the mons veneris and labia. Each measures about 4 or 5 inches in length, and their direction is upward, forward, and outward. The peritoneum which invests them is sometimes prolonged (as in the fetus) for some distance into the inguinal canal, and forms the canal of Nuck. Generally this canal is obliterated.

The *anterior* or *vesicouterine ligaments* stretch between the bladder and the uterus; the *posterior,* between the uterus and rectum, hence called the *rectouterine,* forming a pouch, the cul-de-sac of Douglas.

The two *lateral* or *broad ligaments* pass from the sides of the uterus to the sides of the pelvis, thus dividing the latter into two parts. They are formed by the coalescence of the peritoneal layers investing the anterior and posterior surfaces of the uterus, and contained between the two layers—the Fallopian tube at the upper margin; the round ligament below and in front of the tube; the ovary and its ligament enfolded by the posterior layer; and the uterine bloodvessels, lymphatics, and nerves.

THE FALLOPIAN TUBES

The **Fallopian tubes**, or oviducts, run from the upper angles of the uterus toward the sides of the pelvis, and near their termination bend downward, backward, and inward. They are 3 to 4 inches long, are at first narrow, then enlarge near the extremity (ampulla), and end in a fimbriated margin, one of the fimbriæ being attached to the ovary. The canal is very narrow at the uterine end (ostium uterinum), begins to widen in the outer half to form the ampulla, and at its termination again narrows (ostium abdominale).

The *tubes* consist of a peritoneal coat, a muscular coat composed of internal circular and external longitudinal fibers, and a mucous coat. The latter is continuous with that of the uterus and with the peritoneum, the epithelium being ciliated columnar, and it is thrown into longitudinal wrinkles, more marked in the outer half of the tube.

THE OVARIES

The **ovaries** are analogous to the testes, and are flattened, oval bodies, measuring $1\frac{1}{2}$ inches long, $\frac{3}{4}$ inch wide, and $\frac{1}{2}$ inch thick, each weighing 60 to 100 grains. Of each, the two sides are free as well as the convex border, the straight border (hilum) being attached to the broad ligament and admitting the vessels, etc. Its outer end is attached by the fimbria ovarica to the Fallopian tube, its inner end to the uterus by the ligament of the ovary, a dense, fibromuscular cord attached to the uterus below and behind the tube.

The ovary **consists of** a stroma in which are embedded the Graafian follicles, and of a covering of columnar cells, the germinal epithelium. The stroma is invested beneath the epithelium by a dense fibrous layer, the tunica albuginea, and consists of connective tissue with numerous cells, as well as of elastic fibers, with some muscular tissue and bloodvessels.

The **Graafian follicles** consist of an external fibrous coat, and beneath it a coat called the ovicapsule, lined internally with a layer of cells, the **membrana granulosa.** Within this last-named layer is the ovum, invested by the **discus proligerus,** a layer of cells derived from the membrana granulosa, together with the liquor folliculi.

THE PAROVARIUM

The **parovarium, organ of Rosenmüller,** is a fetal remnant lying in the broad ligament between the ovary and Fallopian tube. It consists of several vertical tubes, lined with epithelium, whose lower ends run toward the hilum of the ovary, and whose upper ends are united by a horizontal tube, the duct of Gaertner.

THE MAMMARY GLANDS

These are accessory to the generative system and secrete the milk. They are two rounded eminences, one on each side of the thorax, between the sternum and axilla and the third and seventh ribs. Just below the centre is a conical eminence, the nipple, which is dark, and is surrounded by a pinkish **areola** which darkens in pregnancy. It presents the orifices of the **lactiferous ducts,** and consists of vessels mixed in with plain muscular fibers, and by friction may be made to undergo erection.

The **mamma** consists of a number of lobes separated by fibrous tissue and some adipose tissue. The **lobes** are divided and subdivided into smaller lobules, which are in turn made up of alveoli. Each lobe has an excretory (galactophorous) duct, and these, about sixteen in number, converge to the areola, there dilating into **ampullæ,** or sinuses. They then become smaller again, and surrounded by areolar tissue and vessels, pass through the nipple to empty on the surface by separate orifices.

THE DUCTLESS GLANDS

THYROID GLAND

The thyroid gland is a very vascular organ, situated at the front of the neck, overhanging the upper rings of the trachea and laterally extending as high as the oblique line on the ala of the thyroid cartilage, and as low as one inch above the upper border of the sternum, when the head is extended. It weighs about one ounce; slightly heavier in the female. It has three lobes—**two lateral** connected by an **isthmus**; and one **third** or **middle lobe**—presenting (the former) two surfaces, and an anterior and posterior border. It is firmly attached to the cricoid cartilage and posterior fascia of the trachea by two **lateral** or **suspensory ligaments,** and its lobes and isthmus are enclosed within a fibrous capsule derived from the pretracheal portion of the **deep cervical fascia.**

The **external surface** of the lateral lobes is covered by the skin, superficial fascia, a portion of the platysma muscle, deep fascia, sternomastoid, anterior belly of omohyoid, sternohyoid, and sternothyroid muscles. The **internal surface** is moulded over the thyroid and cricoid cartilages, the trachea, inferior constrictor muscle, and posterior part of cricothyroid muscles, the esophagus (mostly on the left), the superior and inferior thyroid arteries, and recurrent laryngeal nerves.

The **anterior borders** are thin, and incline obliquely from above downward and inward to the median line. The **posterior borders** are rounded and rest on the carotid sheath.

The **middle lobe** arises from the upper part of the isthmus and left lobe, extending as high as the middle of the hyoid bone in front of the thyroid cartilage.

The **isthmus** lies on the second and third ring of the trachea, and measures about $\frac{1}{2}$ inch in breadth and depth. It has the cricothyroid artery and vein above it, and the lower border is in relation with the inferior thyroid veins. Care should be taken during tracheotomy not to injure these structures.

The superior and inferior thyroid arteries, sometimes a thyroidea ima branch from the innominate artery, supply the gland. The veins are the superior and inferior accessory thyroids, a transverse, and sometimes a middle thyroid vein. The **lymphatics** drain into the superior and inferior set of deep cervical nodes, and the nodes in front of the bifurcation of the trachea; also an ascending trunk passes to the node in front of the larynx. The **nerves** are derived from the inferior laryngeal and the middle and inferior cervical ganglion of the sympathetic. The **accessory thyroids** are small isolated masses of thyroid tissue sometimes present, found about the lateral lobes of the thyroid gland in the sides of the neck or just above the hyoid bone.

PARATHYROID GLANDS

The parathyroid glands are small reddish-brown bodies, composed of masses of cells, arranged in a more or less reticular manner, with numerous intervening bloodvessels. They are usually found one on either side (the superior) at the level of the lower border of the cricoid cartilage, behind the junction of the pharynx and esophagus, and in front of the prevertebral fascia. The lower are just below the lower edge of the lateral lobe one on either side. There are usually four, but may be only three, or, again, as many as six or eight. Their location is variable.

THYMUS GLAND

The thymus gland is a temporary organ, attaining its full size at the end of the second year and gradually shrinking until puberty, when it entirely disappears. Consists of two lateral lobes placed in close contact along the median line. It is found in the superior mediastinum, covered by the sternum and the origins of the sternohyoid and sternothyroid muscles; below, it rests upon the pericardium, and separated from the arch of the aorta and great vessels by fascia. In the neck it lies on the front and sides of the trachea beneath the sternohyoid and sternothyroid muscles. It is pinkish gray in color. About 2 inches in length, $1\frac{1}{2}$ inches in breadth, below, and about $\frac{1}{4}$ inch in thickness.

SPLEEN

The spleen is the largest of the ductless glands. It is found in the left hypochondrium, entirely surrounded by peritoneum, except around the hilum, which attaches it to the fundus of the stomach (the gastrosplenic omentum). It is purplish in color, oblong, flattened, tetrahedral form, soft, of a very friable consistency, and highly vascular. It measures 5 inches in length, 2 to 3 inches in width, and 1 to $1\frac{1}{4}$ inches in thickness at the centre. It weighs $6\frac{1}{2}$ ounces.

The Relations.—The **external** or **phrenic** surface is in relation with the under surface of the diaphragm, which separates it from the ninth, tenth, and eleventh ribs on the left side, and the intervening lower border of the lung and pleura above. The **gastric surface** is concave, and is in relation with the posterior part of the fundus of the stomach and the tail of the pancreas. It presents near its inner border a long fissure, the hilum, in which are several openings for the splenic vessels and nerves to enter and leave the organ. The **renal surface** is flattened somewhat and is in relation with the outer and upper surface of the left kidney, and sometimes the suprarenal capsule.

The spleen is attached to the stomach by the **gastrosplenic** omentum; between its layers pass the vasa brevia and left gastroepiploic arteries and veins. The **lienorenal** ligament is a peritoneal fold which attaches it to the upper pole of the left kidney, and the **phrenocolic** assists to support it by its attachment to the diaphragm.

The **arteries** are the splenic from the celiac axis. The **vein** is the splenic, which drains into the portal system.

The **lymphatics** drain into the splenic nodes, and the latter empty into the celiac nodes. The **nerves** are derived from the splenic plexus of the sympathetic system.

SUPRARENAL GLANDS

The **suprarenal glands** are two flattened bodies, of a yellowish color, found in the epigastrium, lying behind the peritoneum, and above and in front of the upper extremity of each kidney.

They are triangular in shape, $1\frac{1}{2}$ to nearly 2 inches in length, less in width, and $\frac{1}{4}$ of an inch in thickness.

The **relations** of the **right suprarenal gland.** It lies behind the inferior vena cava and the right lobe of the liver, and in front of the diaphragm; below is the kidney. The **left,** slightly larger than the right, lies on the left crus of the diaphragm; below is the kidney.

The **arteries** are the suprarenal from the abdominal aorta, a branch from the renal and one from the phrenic artery. The **veins** empty into the inferior vena cava on the right side, and into the renal vein on the left side. The **lymphatics** drain into the nodes at the corresponding sides of the aorta. The **nerves** are derived from filaments of the celiac and renal plexuses. The **accessory suprarenal glands** are often to be found in the tissue around the suprarenals.

CAROTID GLANDS

The carotid glands or bodies are small reddish-brown bodies, oval in shape, their long diameter measuring $\frac{1}{5}$ of an inch. They are found in the cervical region, at the bifurcation of the common carotid artery into the internal and external carotid trunks.

COCCYGEAL GLAND

The coccygeal gland, or body, or Luschka's gland, is as large as a millet seed, found at the tip of the coccyx. It is connected with the middle sacral artery.

QUESTIONS ON SPLANCHNOLOGY

THE ORGANS OF RESPIRATION

Describe each of the cartilages of the larynx.

Of what are the true vocal cords composed?

To what part of the arytenoid cartilages are the true vocal cords attached?

Name the branches of each bronchus.

What is the lowest point the pleuræ reach?

Which lung is the larger?

Describe the fissure of each lung.

Locate the apices of the lungs in the neck.

THE ORGANS OF DIGESTION

Name the salivary glands, giving the location of each.

Give the names of the ducts of the salivary glands, and tell where they enter the mouth.

How long is the esophagus?

Give the relations of the esophagus in the neck and in the thorax.

Into what regions is the abdomen divided?

At what place are the greater and lesser sacs of the peritoneum continuous?

Trace the peritoneum in the median line from above downward and back again to the starting point.

Trace the peritoneum transversely at the level of the foramen of Winslow.

Where can the pancreas be reached by cutting only one layer of peritoneum after the belly is opened?

Describe the peritoneal relations of the duodenum, rectum, and bladder.

Name the pouches or cul-de-sacs formed by the peritoneum.

Give the relations of the stomach.

Trace the duodenum through its various curves, from the pylorus to the jejunum.

How are the large and small intestines to be distinguished?

Describe the appendix vermiformis.

Where does the sigmoid flexure of the colon begin, and where does it end?

What are the relations of the duodenum?

Describe the ileocecal valve.

What is the cul-de-sac of Douglas?

What are the lobes of the liver?

Which lobe is between the gall-bladder and longitudinal fissure?

What are the surfaces of the liver?

How low down does the free margin of the liver normally extend?

Give the structures in relation with the inferior surface of the liver.

Where does the gall-duct empty?

Locate the gall-bladder on the abdominal wall.

Give the relations of the pancreas.

THE URINARY ORGANS

Just where do the kidneys lie?
How can you tell to which side a kidney belongs?
Give the relations of the ureters.
What are the ligaments of the bladder?

THE ORGANS OF REPRODUCTION

Where is the prostate located?
Describe the male urethra.
Name the coverings of the testicle.
Locate the internal abdominal ring.
Describe precisely the inguinal canal.
What is the relation, as to position, of the epididymis to the testicle?
What part of the vaginal wall is in contact with the peritoneum?
Describe the broad ligaments of the uterus, giving the relations of the contained structures.
How far down does the peritoneum come anteriorly on the uterus?
Describe the Fallopian tubes.
How large is an ovary?

THE DUCTLESS GLANDS

Of what parts is the thyroid gland composed, and just where are they situated?
What are the surfaces of the spleen?
Opposite what ribs in the midaxillary line should the spleen lie?
Does the spleen vary much in size?
Give the relations of the spleen.

A SELECTED LIST OF STATE BOARD EXAMINATION QUESTIONS

The following questions are taken from recent examinations held by the Medical Examiners of the several States, and are given here as additional assistance to the student preparing himself in the subject.

The references in **black type** indicate the pages where information will be found supplying correct answers to questions.

1. Describe the shoulder-joint. **Pages 132-135.**
2. Describe the appendix vermiformis and give its relations. **Page 433.**
3. Describe the prostate gland and give its relations. **Page 451.**
4. Describe the tibia and give in detail its articulations. **Pages 103-105.**
5. Describe the fascia lata and give its regional anatomy. Page **219.**
6. Describe the female perineum and the relations of its muscles and fasciæ. **Pages 189 and 193.**
7. Describe the gross anatomy of the stomach and give its relations. **Pages 427-429.**
8. Describe the distribution of the peritoneum. **Pages 423-425.**
9. Locate the following bony points: (a) Mastoid process, (b) olecranon, (c) external malleolus, (d) acromion, (e) spine of ischium. **Pages 42, 80, 86, 97,** and **105.**
10. State the names and give the attachments of the muscles of mastication. **Pages 173-175.**
11. Describe the femoral artery as to (a) origin, (b) course, (c) branches. **Page 277.**
12. Describe the inferior vena cava. **Page 292.**
13. State the origin and give the course of the musculospiral nerve (nervous radialis) and mention the names of *two* of its terminal branches. **Page 363.**
14. Describe the spleen and give its relations to surrounding structures and organs. **Page 468.**
15. State origin, course, and distribution to the stomach of the left vagus (pneumogastric) nerve. **Page 350** and **353.**
16. Give the minute anatomy of the lobules of the liver. **Pages 439** and **440.**
17. What are the muscles attached to (a) the posterior border of the ulna, (b) the spine of scapula? **Pages 176, 200, 203, 204, 207, 211,** and **212.**
18. Give the topographic anatomy of (a) the internal abdominal ring, (b) the external abdominal ring. **Pages 186** and **188.**
19. Describe the articulation of the head of a rib, in the middle of the series, with the vertebræ. **Pages 121-122.**
20. Give a detailed description of the rectum. State the blood supply and the nerve supply of the rectum. **Pages 435, 436,** and **437.**
21. Give the articulations of the inferior turbinate bone. **Page 62.**
22. Where are the medulla oblongata, the pons Varolii, and the cerebellum located, and how are they separated from the cerebral hemispheres? **Pages 307, 309,** and **310.**

23. Name the nerves that supply the muscles of the forearm and hand. **Pages 360, 361, 363,** and **364.**

24. Where does the internal carotid artery commence? Where does it terminate and into what does it divide? **Pages 256** and **258.**

25. What bones form the articular surface of the knee-joint? Name the ligaments of the knee-joint. **Page 146.**

26. Name the tunics or coats of the eye from without inward; also the refracting media, or humors, of the eye. **Pages 382, 383,** and **386.**

27. Name the branches of (a) the ascending aorta; (b) arch of the aorta. **Page 248.**

28. Give origin, insertion, action, and nerve supply of the Brachialis anticus muscles. **Pages 203** and **204.**

29. Where does the right lymphatic duct empty its contents? What part of the body does it drain? **Page 296.**

30. Describe in detail the movements of the knee-joint. **Pages 149-151.**

31. What is the nerve supply of the flexor group of muscles of the forearms? **Page 209.**

32. What are the surface points for the following: Bifurcation of the trachea; gall-bladder; spleen; termination of the spinal cord; kidney? **Pages 304, 406, 440, 444-446,** and **468.**

33. Describe the course of the portal vein, and give its relations. **Page 295.**

34. Describe the venous and arterial blood supply of the ovaries. **Pages 273** and **292.**

35. What are the surface markings of the liver? **Pages 437** and **439.**

36. Describe the pleural sac, including attachments and contents. **Pages 406-407, 408-410.**

37. Describe the arrangement of the dura mater and state functions. **Page 306-307.**

38. Give the anatomical relations of the stomach. **Page 428.**

39. What is Poupart's ligament? State origin and insertion, and the structures which pass under it. **Pages 185, 186, 188, 221, 227, 293,** and **367.**

40. State origins of vertebral, internal mammary, and basilar arteries. **Pages 259, 260,** and **262.**

41. Name the largest cranial nerve. How many roots has it, and what is its superficial origin? Why is it called a compound nerve? **Pages 338-339.**

42. Describe the second nerve, giving its course and position. What is its exclusive distribution? **Pages 335-337.**

43. Locate and give the gross anatomy of the medulla oblongata. **Pages 307-308.**

44. Describe the occipital bone. **Pages 33-36.**

45. Name the carpal bones. **Page 92.**

46. Name varieties of articulations. Give example of each. **Page 114.**

47. Give origin and distribution of great sciatic nerve. **Page 371.**

48. Give origin, insertion, and nerve supply of Quadratus lumborum, Brachialis anticus, Orbicularis oculi, and Sartorius. **Pages 170, 203, 204, 220, 224,** and **225.**

49. Describe the epithelium of the pharynx. **Page 421.**

50. What arteries form the circle of Willis? **Page 261.**

51. What and where is the pituitary body? **Page 318.**

52. Describe the upper third of the femur. **Page 99.**

53. Give the class of joint, the articulation, and ligaments of the shoulder joint. **Page 132.**

54. Trace blood from the heart by way of the subclavian artery to the circle of Willis, naming the arteries uniting to form the circle. **Pages 258-261.**

55. Name the muscles of the anterior chest, and give origin and insertion of the largest one of them. **Page 196.**

56. Name the main superficial venous trunks of the upper arm, describing one of them. **Page 290.**

57. Describe the gall-bladder and the bile-ducts. **Pages 440 and 441.**

58. Describe the great sciatic nerve. **Page 371.**

59. Describe the rectum. **Page 435.**

60. Name the bones of the lower extremity. **Page 93.**

61. Name and locate the valves of the heart. **Pages 243-246.**

62. Locate the spleen and describe its gross anatomy. **Page 468.**

63. Describe in full the pulmonary veins. **Page 283.**

64. Describe the contents in Scarpa's triangle and give their relations. **Page 277.**

65. Name the lobes and ventricles of the brain. **Pages 310-328.**

66. Name the ligaments supporting the uterus and describe its blood supply. **Page 273, 274, 463,** and **464.**

67. Give the general classification of bones. **Page 17.**

68. Name the bones of the upper extremity. **Page 77.**

69. Describe the diaphragm, giving origin, insertion, nerve supply, and action. **Pages 194** and **195.**

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